Base Realignment and Closure
Program Management Office West
1455 Frazee Road, Suite 900
San Diego, CA 92108-4310

FINAL

REMOVAL ACTION COMPLETION REPORT

December 12, 2007

DCN: ECSD-5713-0072-0005

**INSTALLATION RESTORATION SITE 02 --
NORTHWEST AND CENTRAL
PARCEL E, HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA**

DEPARTMENT OF THE NAVY
BASE REALIGNMENT AND CLOSURE
PROGRAM MANAGEMENT OFFICE WEST
1455 FRAZEE RD, SUITE 900
SAN DIEGO, CA 92108-4310

5090
Ser BPMOW.SP/0147

Mr. Mark Ripperda
U.S. EPA
75 Hawthorne Street, (SFD 8-3)
San Francisco, CA 94105

Mr. Tom Lanphar
Department of Toxic Substances Control
700 Heinz Avenue, Bldg. F, Suite 200
Berkeley, CA 94710

Mr. Erich Simon
California Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94612

Dear BCT Members:

Enclosed is the Final Removal Action Completion Report, IR-02 Northwest and Central Parcel E, at Hunters Point Shipyard, San Francisco, California, of December 12, 2007. Thank you for your comments on this report. The Final Response to Comments document is included as Appendix N.

If you have questions, please contact Ms. Sarah Penn at (619) 532-0962.

Sincerely,

KEITH FORMAN
BRAC Environmental Coordinator
By direction of the Director

Enclosure: (1) Final Removal Action Completion Report, IR-02 Northwest and Central Parcel E, at Hunters Point Shipyard, San Francisco, California, of December 12, 2007

Copy to :(Hard Copy and CD)
Ms. Vandana Kohli
Environmental Management Branch,
1616 Capitol Avenue, (MS 7405)
P.O. Box 997377
Sacramento, CA. 95899-7377

Mr. Patrick Shea
City of San Francisco – Public Library
100 Larkin Street
Government Information Center, 5th Floor
San Francisco, CA 94102

Anna E. Waden Library
City of San Francisco – Public Library
5075 Third Street
San Francisco, CA 94124

Mr. Peter Stroganoff
ROICC San Francisco Bay Area,
Engineering Field Activity West
2450 Saratoga Street, Suite 200
Alameda, CA 94501-7545

Mr. Mike Mentink
Department of Navy
Public Affairs Office
410 Palm Avenue, Building One
Code 00PA
San Francisco, CA 94130

Mr. Leon Muhammad
5048 Third Street
San Francisco, CA 94124

Radiological Affairs Support Office
Building 1971, NWS P.O. Drawer 260
Yorktown, VA 23691-0260

Mr. Matthew Slack
Radiological Affairs Support Office
Building 1971 , NWS P.O. Drawer 260
Yorktown, VA 23691-0260

Mr. Steve Hall
Tetra Tech EMI
1230 Columbia Street
Suite 1000
San Diego, CA 92101

Ms. Laurie Lowman
Radiological Affairs Support Office
Building 1971
NWS P.O. Drawer 260
Yorktown, VA 23691-0260

Ms. Karla Brasaemle
U.S. EPA Contractor, Tech Law, Inc.
90 New Montgomery Street, Suite 1010
San Francisco, CA 94105

Ms. Diane Silva (3 Hard Copies + 1 CD)
Records Manager (EVR.DS)
937 Harbor Drive
FISC Bldg 1 3rd Floor Room 71
San Diego, CA 92132

Mr. Michael Jacobvitz
5341 Old Redwood Highway
Suite 300
Petaluma, CA 94954

Ms. Dorinda Shipman
555 Montgomery Street, Suite 1300
San Francisco, CA 94111

Ms. Barbara Bushnell
6 Vistaview Court
San Francisco, CA 94124

Copy to: (CD Only)
Ms. Amy Brownell
City of San Francisco
Department of Public Health
1390 Market Street, Suite 910
San Francisco, CA 94102

Mr. Michael Sharpless
55 2nd Street 24th Floor
San Francisco, CA 94104

Mr. Jeff Austin
49 Stevenson Street, Suite 525
San Francisco, CA 94105

Dr. Peter T. Palmer
1600 Holloway Ave., TH 730
San Francisco 94132

Mr. Gregg Grist
Tech Physics
1658 27th Ave.
San Francisco, CA 94122

Mr. Michael McGowan
4634 3rd Street
San Francisco, CA 94124

Ms. Rona Sandler
City Hall, Room 234
1 Dr Carlton B Goodlett Place
San Francisco, CA 94102

Mr. Robert Cotter
P.O. Box 0915
San Francisco, CA 94143

Mr. David Belk
50 Medical Center Way
San Francisco, CA 94143

Base Realignment and Closure
Program Management Office West
1455 Frazee Road, Suite 900
San Diego, California 92108-4310

CONTRACT NO. N68711-98-D-5713
CTO NO. 0072

FINAL

REMOVAL ACTION COMPLETION REPORT

December 12, 2007

INSTALLATION RESTORATION SITE 02 -- NORTHWEST AND CENTRAL PARCEL E, HUNTERS POINT SHIPYARD SAN FRANCISCO, CALIFORNIA

DCN: ECSD-5713-0072-0005

TETRA TECH EC, INC.
1230 Columbia Street, Suite 750
San Diego, CA 92101-8536

Ryan Ahlersmeyer, P.G.
TtEC Project Manager

Daryl DeLong
Project Radiation Safety Officer

TABLE OF CONTENTS

PAGE

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

PAGE

TABLE OF CONTENTS
(Continued)

LIST OF TABLES

LIST OF FIGURES

APPENDICES

ABBREVIATIONS AND ACRONYMS

β	beta
%R	percent recovery
µCi	microcurie
µg/kg	micrograms per kilogram
AEC	Atomic Energy Commission
AM	Action Memorandum
BA	Biological Assessment
BART	Bay Area Rapid Transit
bgs	below ground surface
BMP	best management practice
BRAC	Base Realignment and Closure
C&T	Curtis and Tompkins, Ltd.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
COC	chemicals of concern
cpm	count per minute
^{137}Cs	cesium-137
CTO	Contract Task Order
cy	cubic yard
DCGL	derived concentration guideline level
DGPS	Differential Global Positioning System
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DON	U.S. Department of the Navy
DQA	Data Quality Assessment
DQO	Data Quality Objectives
EPA	U.S. Environmental Protection Agency
EPP	Environmental Protection Plan
ESA	Endangered Species Act
EWI	Environmental Work Instruction
FCR	field change request

ABBREVIATIONS AND ACRONYMS
(Continued)

FWENC	Foster Wheeler Environmental Corporation
FS	Feasibility Study
HazCat	Hazardous Categorization
HPS	Hunters Point Shipyard
ICP	inductively coupled plasma
IN	inch
IR	Installation Restoration
J	estimated value
LLMW	low-level mixed waste
LLRW	low-level radioactive waste
m^2	square meter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	minimum detectable activity
mg/L	milligram per liter
mil	thousands of an inch
MPPEH	material potentially presenting an explosive hazard
MS/MSD	matrix spike and matrix spike duplicates
msl	mean sea level
NAVFAC SW	Naval Facilities Engineering Command, Southwest
NAVSEA	Naval Sea Systems Command
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
pCi/g	picocurie per gram
PPE	personal protective equipment
ppt	parts per thousand
PRG	preliminary remediation goal
QA	quality assurance
QC	quality control

ABBREVIATIONS AND ACRONYMS
(Continued)

^{226}Ra	radium-226
RAB	Restoration Advisory Board
RACR	Removal Action Completion Report
RAO	Remedial Action Objective
RASO	Radiological Affairs Support Office
RCT	Radiological Control Technician
RI	Remedial Investigation
ROC	radionuclide of concern
ROICC	Resident Officer in Charge of Construction
RPD	relative percent difference
RPM	Remedial Project Manager
RRO	Radiological Remedial Objective
RSO	Radiation Safety Officer
SAP	Sampling and Analysis Plan
SCRS	Surface Confirmation Radiation Survey
SFRA	San Francisco Redevelopment Agency
SHSP	Site Health and Safety Plan
SOP	Standard Operating Procedure
^{90}Sr	strontium-90
SVOC	semivolatile organic compound
SWPPP	Stormwater Pollution Prevention Plan
TCRA	Time-Critical Removal Action
TDS	total dissolved solids
TOG	total oil and grease
TPH	total petroleum hydrocarbons
TPH-d	quantified as diesel
TPH-extractable	total extractable petroleum hydrocarbons
TPH-g	quantified as gasoline
TPH-purgeable	total purgeable petroleum hydrocarbons
Triple A	Triple A Machine Shop, Inc.
TtEMI	Tetra Tech EM, Inc.

ABBREVIATIONS AND ACRONYMS
(Continued)

TtEC	Tetra Tech EC, Inc.
TtFW	Tetra Tech FW, Inc.
U	not detected
U&A	Uribe and Associates
UJ	estimated value at less than the laboratory reporting limit
UXO	unexploded ordnance
VOC	volatile organic compound
yd^2	square yard

EXECUTIVE SUMMARY

This Removal Action Completion Report describes the implementation of a time-critical removal action at Installation Restoration Site-02 Northwest and Central located within Parcel E at Hunters Point Shipyard, San Francisco, California. The Department of the Navy, Naval Facilities Engineering Command, Southwest, and the Radiological Affairs Support Office directed the removal action.

Hunters Point Shipyard is located on a long promontory in the southeastern portion of San Francisco that extends into San Francisco Bay. At the start of World War II, the Department of the Navy took possession of the property and operated it as a shipbuilding, repair, and maintenance facility until 1974, when the shipyard was deactivated. From 1976 to 1986, the Department of the Navy leased the property to a private ship repair company. When that company ceased operations, the Department of the Navy resumed occupancy through 1989. Since previous operations had left hazardous materials on site, Hunters Point Shipyard was placed on the National Priorities List in 1989 as a Superfund site.

Previous radiological investigations identified radium-226 contamination in soil at Installation Restoration Site-02 Northwest and Central. A Radiological Remedial Objective of 1 picocurie per gram above background levels, not to exceed 2 picocuries per gram total, for radium-226 was established based upon agreement between the Navy's Radiological Affairs Support Office and United States Environmental Protection Agency, Region IX. Background reference area samples were collected in a non-impacted portion of the Parcel E area. Based on these results, radium-226 background levels were established as 0.883 picocurie per gram. The *Final Historical Radiological Assessment, Volume II* (Naval Sea Systems Command, 2004) also identified strontium-90 and cesium-137 as radionuclides of concern for Installation Restoration Site-02. The removal action objectives for these two radioisotopes were 10.8 and 0.113 picocurie per gram, respectively. The removal action objectives for this work is documented in the *Final Basewide Radiological Removal Action, Action Memorandum - Revision 2006* (Tetra Tech EC Inc., 2006). If additional radionuclides were detected during the screening activities conducted during this removal action, the relevant Radiological Remedial Objective established in the *Base-wide Radiological Work Plan* (Tetra Tech FW, Inc. 2005a) for each confirmed radionuclide was adopted for this removal action. The radiological survey, screening, sampling, and post-excavation sampling during this removal action was conducted in accordance with the *Base-wide Radiological Work Plan* (Tetra Tech FW, Inc., 2005a) following guidance from the *Multi-Agency Radiation Survey and Site Investigation Manual* (Department of Defense et al., 2000a) *NUREG-1575*.

The time-critical removal action was conducted in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act and the National Oil and Hazardous Substances Pollution Contingency Plan. The time-critical removal action was conducted pursuant to the *Final Basewide Radiological Removal Action, Action Memorandum* (Department of the Navy, 2001a). A Project Work Plan (Tetra Tech EC, Inc., 2005a) was prepared and issued to define the approach to conducting field work associated with this removal action (Tetra Tech EC, Inc., 2005a).

The Remedial Action Objectives for this time-critical removal action were to implement the Action Memorandum (Department of the Navy, 2001a) and to protect public health and welfare and the environment by physically removing and disposing of radioactive contaminants that exceeded the radiological remedial objectives, thus preventing potential migration of contaminated material within or outside of the site. The Radiological Remedial Objectives that were adopted were established by the Department of the Navy in consultation with United States Environmental Protection Agency, Region IX. Any remaining non-radioactive (chemical) contamination will be addressed through the Installation Restoration Program process, consistent with Comprehensive Environmental Response, Compensation, and Liability Act and the National Oil and Hazardous Substances Pollution Contingency Plan.

The Remedial Action Objectives were planned to be achieved by excavation and removal of debris and other materials with radioactivity above the Radiological Remedial Objectives within the Installation Restoration Site-02 excavation boundary. The excavation boundary was pre-determined based on previous radiological investigations.

The major field activities associated with the time-critical removal action included clearing of vegetation; in-situ radiological surveys; excavation of soil; debris, drums, and containers with unknown chemical contents; air monitoring; ex-situ radiological screening; removal of groundwater monitoring wells; segregation of contaminated soil and debris; stockpiling of excavated soil and debris; post-excavation confirmation sampling; backfill placement and compaction with screened soils and import materials; site restoration; and waste classification, storage, and disposal.

A grid system was established over the excavation area to track the required radiological surface surveying within the excavation boundary, control and record excavation progress, and assist in the collection of post-excavation samples. The excavation was performed in a series of six-inch or twelve-inch lifts. Radiological instruments were used to perform surface screening prior to removing each lift. The alternating screening and excavating cycle was continued until the excavation reached Bay Mud or the maximum depth of ten feet below ground surface. The top of the Bay Mud, where present, was approximately three to five feet below ground surface. This depth was pre-determined based on previous radiological investigation. Additionally, each grid was numbered to track the excavation depth and associated sampling.

Upon completion of excavation activities within the area, post-excavation radiological soil sampling and screening was performed to document the radiological status of the bottom surface of the excavation.

Prior to backfilling the excavation area, topographical and geophysical surveys of the sidewalls and excavation bottom were conducted. Geotextile fabric was placed along the excavation bottom and sidewalls as a boundary indicator. Excavated soils determined to be in compliance with the Radiological Remedial Objectives were used to backfill the excavation. Additional fill material was necessary to complete backfilling. Therefore, materials originally from the Bay Area Rapid Transit comprising limited sections of the material screening pads were used to backfill the excavation to 3 feet below ground surface. The final 3 feet of the excavation was backfilled with clean import fill material to provide a barrier and bring the site to final grade.. Since backfill and grading, the Installation Restoration Site-02 Northwest and Central Area is undergoing natural revegetation, with periodic visual inspections performed to ensure appropriate drainage and storm water protection.

The originally estimated volume of soil to be removed at the site was approximately 44,100 cubic yards; however, the final amount excavated was approximately 49,500 cubic yards. The limits of the excavation remained within the planned excavation boundary. The effectiveness of the removal action was established by evaluating the post-excavation bottom and sidewall samples. All samples were below the Radiological Remedial Objectives for strontium-90 and cesium-137. For the systematic grid samples, 155 of 160 samples were below the Radiological Remedial Objectives for radium-226. For the random grid samples, 59 of 63 samples obtained were below the Radiological Remedial Objectives for radium-226. All sidewall samples (29) were below the Radiological Remedial Objectives for radium-226. In addition, of the 9 exceedences described above, the highest radium-226 result was 6.225 picocuries per gram, with the remainder of the results below 3.783 picocuries per gram. Further, 2,342 point sources and pieces of radioactively contaminated debris were removed during the excavation at Installation Restoration Site-02 Northwest and Central. Additionally, no further investigation was made to determine if additional devices would be found below the extent of the investigation.

The Removal Action Objectives for radiological materials were achieved within the pre-determined boundaries of the Installation Restoration Site-02 Northwest and Central excavation.. Any remaining radiological materials at the excavation site are now under a cap of radiologically screened soil, thereby eliminating some of the pathways of exposure to hazardous substances for surrounding populations and ecosystems, at the limit of the excavation. Limited non-radiological chemical contamination encountered during the radiological removal was removed, with the majority of the excavated and radiologically screened material being used as backfill. Chemical characterization samples were collected from the excavation sidewalls and bottom and from stockpiles representative of discrete depth intervals. This information is available to aid in refining the current understanding of chemical contamination at and adjacent to the site.

Recommendations for actions at and or adjacent to the Installation Restoration Site-02 Northwest and Central area include the following:

- Evaluate all data (both chemical and radiological) collected during and subsequent to removal action activities with respect to the contaminant distribution as presented in the Parcels E and F conceptual site models. This evaluation should include an assessment of remedial options for Installation Restoration Site-02 Northwest and Central and Areas 8, 9, and 10 in Parcel F.
- Continue regular groundwater monitoring to identify and assess the impact of the removal action activities described in this Removal Action Completion Report.
- Complete the disposal of all project-generated soil not used as backfill material.
- Evaluate and implement options for disposition of metal debris, cable, and wood material currently staged and secured as low-level radioactive waste in Parcel E, as appropriate.

1.0 INTRODUCTION

This Removal Action Completion Report (RACR) describes the implementation of a Time-Critical Removal Action (TCRA) undertaken at Installation Restoration (IR) Site-02 Northwest and Central (IR-02) within Parcel E, located at Hunters Point Shipyard (HPS), San Francisco, California (Figure 1-1). The U.S. Department of the Navy (DON), represented by the Base Realignment and Closure (BRAC) Program Management Office (West), Naval Facilities Engineering Command, Southwest Division (NAVFAC SW), and the Radiological Affairs Support Office (RASO), directed this removal action. The TCRA was conducted in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This removal action was performed under Contract Number N68711-98-D-5713 and Contract Task Order (CTO) Number 0072.

Hunters Point Shipyard's operational history and subsequent investigative data indicated that IR-02 is an area with an elevated concentration of radioluminescent devices, debris, and associated contamination. The decision to investigate and remediate sites with localized radiological material is documented in the *Final Basewide Radiological Removal Action Memorandum* (referred to hereinafter as the Action Memorandum [AM]) (DON, 2001a).

This Removal Action Completion Report describes the scope and the specific activities involved in the implementation of the TCRA for IR-02. The TCRA was implemented to limit the human and ecological receptor exposure, and to eliminate the potential threat posed by future migration and/or off-site release of these contaminants. Such a release could occur as a result of erosion, weathering, or seismic events. The major field activities associated with the TCRA included clearing of vegetation; in-situ radiological surveys; excavation of IR-02 debris and associated sediment; ex-situ radiological screening; segregation of contaminated soil and debris; stockpiling of excavated soil and debris; post-excavation confirmation sampling; backfill and site restoration; and waste classification, storage, and disposal.

1.1 OBJECTIVES OF THE TCRA

The remedial action objectives (RAOs) for this TCRA are to implement the AM (DON, 2001a) and to protect public health, welfare, and the environment by physically removing and disposing of radioactive contaminants that exceed the Radiological Remedial Objectives (RROs), thus preventing potential migration of contaminated material within or outside of the site. The Radiological Remedial Objectives that have been adopted were established by the DON in consultation with the U.S. Environmental Protection Agency (EPA). Meeting the specified RROs for the area is the purpose of this TCRA. Residual chemical contamination not addressed during this removal will be addressed through the Installation Restoration Program process, consistent with CERCLA and the NCP.

The TCRA described in this document is part of a larger overall effort by the DON to address radioactive contamination at HPS. Activities being performed as part of this TCRA were coordinated with remediation activities throughout Parcels E and E-2.

1.2 REPORT ORGANIZATION

This RACR has been structured to provide details on the major aspects of the TCRA at IR-02. It is organized as follows:

- Section 1.0 discusses the objectives of the TCRA, the report organization, and the project timeline.
- Section 2.0 discusses the site description and background, the physical characteristics, previous investigations, the nature and extent of contamination, and a summary of the AM driving this TCRA.
- Section 3.0 discusses pre-excavation activities.
- Section 4.0 discusses excavation activities.
- Section 5.0 discusses post-excavation activities.
- Section 6.0 discusses waste characterization data and disposal and/or recycling of wastes generated during the excavation activities.
- Section 7.0 discusses the radiological data and results.
- Section 8.0 discusses the effectiveness of the removal action.
- Section 9.0 discusses the data quality assurance (QA) and quality control (QC) assessment.
- Section 10.0 discusses community relations activities conducted during the project.
- Section 11.0 contains the report recommendations.
- Section 12.0 contains a list of references.
- Appendix A contains the weather data collected during the project.
- Appendix B contains the kick-off meeting agenda.
- Appendix C contains the well destruction forms.
- Appendix D contains the results of the chemical post-excavation sampling results.
- Appendix E contains the backfill material review and acceptance documentation.
- Appendix F contains the results of the waste data and waste manifests.
- Appendix G contains the results of the radiological post-excavation sampling and gamma scan surveys.

- Appendix H contains the survey reports for the project.
- Appendix I contains pertinent project photos.
- Appendix J contains the field change requests for the project.
- Appendix K contains community relations documents for the project.
- Appendix L contains the validated laboratory data packages for the project.
- Appendix M contains the results of the radiological offsite sample analysis for the project.

1.3 TIMELINE

Site mobilization occurred in April 2005, with excavation activities beginning one month later. Excavation and screening progressed through the remainder of 2005. The final depth of the planned excavation was achieved in September 2006, followed by a series of investigative processes intended to yield additional information about the subsurface of the IR-02 site, potentially applicable to other areas of Parcel E. These processes included excavation of a number of potholes to determine the extent and orientation of the Bay Mud unit and investigate the physical nature of material encountered at the bottom of the planned excavation. In addition, a geophysical survey was completed once backfill operations were sufficient to bridge the groundwater infiltrating the excavation site.

Following the activities described above, backfill operations continued through February 2007. Final grading of the excavation was completed February 2007. The IR-02 excavation site is undergoing natural revegetation, with periodic visual inspections performed to ensure appropriate drainage and storm water protection..

2.0 SITE BACKGROUND AND HISTORY

This section presents the facility description and background, the physical characteristics of IR-02, a summary of previous investigations, the nature and extent of contamination, and a summary of the AM (DON, 2001a).

2.1 FACILITY DESCRIPTION AND BACKGROUND

HPS is located on a long promontory in the southeastern part of San Francisco that extends east into San Francisco Bay. Presently, HPS encompasses approximately 848 acres, of which approximately 416 acres are land, the remainder being underwater. The land portion of HPS was purchased by the DON in 1939 and leased to Bethlehem Steel Corporation. At the start of World War II, the DON took possession of the property and operated it as a shipbuilding, repair, and maintenance facility until 1974. The presence of residual radiological contamination is typically associated with the shipbuilding and repair operations or research and development activities performed as part of the Naval Radiological Defense Laboratory programs. The shipyard also served as the decontamination facility for select ships involved in Operation Crossroads. The DON deactivated HPS in 1974. From 1976 to 1986, the DON leased HPS to Triple A Machine Shop, Inc. (Triple A), a private ship repair company. In 1986, Triple A ceased operations and the DON resumed occupancy through 1989. In 1991, HPS was placed on the DON's BRAC list and its mission as a DON shipyard ended in April 1994.

HPS was divided into six parcels, Parcels A through F. In November 2004, Parcel A was transferred to the City and County of San Francisco. In 2004, the DON subdivided Parcel E, creating Parcel E-2 in order to move the Industrial Landfill forward under the CERCLA process. Parcel E-2, 47 acres in size, encompasses former portions of Parcel E, including IR-01/21, the Panhandle Area, parts of IR-02 Northwest, and the area east of IR-01/21 that does not have an IR site designation.

The activities governed by this TCRA deal specifically with IR-02, located in Parcel E. IR-02 is located in the southwestern portion of Parcel E's central area and covers approximately 12 acres (including the area within the fenced boundary) along the shoreline of Parcel E, southeast of the Industrial Landfill at IR-01/21. Parcel E, the majority of which is unpaved and used for industrial support, now occupies 138 acres along the upland shoreline in the southwestern portion of HPS (Figure 1-1).

2.1.1 Operating History

The DON created much of Parcel E by filling in the San Francisco Bay (hereinafter bay) margin with available material, most of which was largely undocumented. Based on the results of numerous investigations, material used included bedrock-derived fill, hazardous waste and debris, and dredge material. Results of previous radiological investigations indicate that devices containing radioactive material, such as those used extensively in shipboard radioluminescent markers, dials, clocks, and other instruments, are present at the IR-02 area. In the 1970s, Triple A excavated a disposal trench in the area, likely bringing previously deposited material to the surface where it was re-worked and distributed. Detailed review of the radiological results indicated that the re-worked material contained radioluminescent devices, debris and associated contamination (PRC Environmental Management, Inc., 1996).

The presence of radiological contamination can largely be attributed to the disposition of radioluminescent devices containing radium-226 (^{226}Ra) and strontium-90 (^{90}Sr) with other shipyard fill material. This was a common practice throughout the military and private industry into the 1960s. The radionuclides cesium-137 (^{137}Cs) and ^{90}Sr may be encountered in contaminated sandblast grit as well as other media. Sandblast grit was used to decontaminate ships involved in atomic weapons testing, and it is possible that the base may have disposed of some of the grit in the IR-02 area (Naval Sea Systems Command [NAVSEA], 2004).

2.1.2 Topography/Structures

The topography of IR-02 is relatively flat, with surface elevations of generally less than 10 feet above mean sea level (msl) when the project started. Most of the area was covered with grass and brush, with a dense growth of brush and trees in the northwestern portion. The shoreline area generally consists of riprap containing rock, concrete, and other debris, with relatively sharp slopes to the bay as well as mudflats and sandy beaches. Groundwater occurs at approximately minus 1 to plus 2 feet above msl (8 to 11 feet below ground surface [bgs]), with a gradient generally to the west toward the bay.

2.1.3 Current and Future Land Use

The current use of IR-02 and most of Parcel E is as undeveloped open space. The planned future use of IR-02 is as "open space" area, identified in the San Francisco Redevelopment Agency (SFRA) Reuse Plan (SFRA, 1997).

2.2 PHYSICAL CHARACTERISTICS

This section presents the physical characteristics of IR-02, which include the geology, hydrogeology, surface hydrology, and climate conditions.

2.2.1 Geology

The geologic units within IR-02, from the surface downward, consist of artificial fill (Qaf), undifferentiated upper sand deposits (Quus), Bay Mud deposits (Qbm), undifferentiated sedimentary deposits (Qu), and Franciscan complex bedrock (KJfm). The artificial fill ranges in thickness from approximately 3 to 22 feet and consists of predominantly dark grayish-brown to light olive-brown silty sand with gravel. Landfill debris has been encountered within the artificial fill. The undifferentiated upper sand deposits consist of yellowish-brown sand with clay and are approximately 4 feet thick. The Bay Mud deposits consist of predominantly dark gray to dark greenish-gray fat clay, with varying proportions of sand and/or silt (5 to 15 percent) and trace amounts of shell fragments. This stratigraphic unit ranges in thickness from approximately 1 to 41 feet and in elevation from -5 to 6 feet above msl and appears to increase from the southeast toward the northwest. The bedrock surface, which dips from the northeast to the southwest toward the bay, is estimated to exist at depths ranging from approximately 200 to greater than 250 feet below msl.

As part of the Phase II investigations, excavated soils were characterized based on the modified Unified Soil Classification System. The characterization identified the predominant soil types as being clay, silt, sand, and gravel. Aside from these four basic soil types, serpentinite fill and debris occurred frequently enough to classify them separately. Serpentinite fill consists of serpentinite gravel, cobbles, and boulders in a clay-rich mix. Industrial waste debris consists of any other lithologic unit containing more than 50 percent concrete, brick, wood, metals, glass, plastic, or other waste material.

2.2.2 Hydrogeology

From the surface downward, the hydrogeologic units at IR-02 consist of the A-aquifer, Bay Mud aquitard, B-aquifer, and bedrock water-bearing zone. The A-aquifer consists of artificial fill and undifferentiated upper sand deposits. Based on groundwater data, the saturated thickness of the A-aquifer is approximately 4 to 7 feet. The Bay Mud aquitard appears to be laterally continuous beneath the site. The B-aquifer consists of undifferentiated sedimentary deposits. Based on groundwater data, the estimated saturated thickness of the B-aquifer is approximately 247 feet. Because bedrock was not encountered during drilling at the site, the composition of the bedrock water-bearing zone is unknown. However, this hydrogeologic unit is estimated to occur at depths ranging from approximately 200 to greater than 250 feet below msl.

The groundwater elevations in the A-aquifer have been found to range from approximately 8 to 11 feet bgs during the wet (December to April) and dry seasons (August to November). The A-aquifer is under unconfined conditions. The groundwater elevation in a single monitoring well installed in the B-aquifer has ranged from approximately 8 to 9 feet bgs. The results of the 1992 and 1996 tidal influence studies indicate that the groundwater elevations in the A-aquifer within approximately 300 feet of the shoreline are influenced by the tidal fluctuations of the bay.

Groundwater in the A-aquifer flows predominantly to the southwest, toward the bay, with hydraulic gradients ranging from 0.001 to 0.04 during the wet and dry seasons, and from 0.003 to 0.04 during the transition period (May). A comparatively steep gradient, which appears to result from groundwater mounding in the western portion of the site, occurs near the eastern boundary of IR-02 during the wet season.

2.2.3 Surface Hydrology

Stormwater is conveyed from IR-02 by surface sheet-flow. IR-02 drains from the east to the west. There were no existing stormwater drainage system or drainage control features located at the site prior to the excavation.

2.2.4 Climate Conditions

A weather station was maintained on HPS during this project. Measurements were taken every half hour of temperature, wind speed, wind direction, and rainfall. The pertinent weather data collected are included in Appendix A.

During the excavation of IR-02 more than twenty-six inches of rain fell at HPS. Radiological detection equipment and vehicle mobility at and adjacent to the IR-02 site was impacted during times of excessive precipitation. During wet conditions, radiological screening was halted until the efficiency of the screening operations could be verified. In addition, due to HPS's location in the Bay Area, wind speeds could be very high and variable throughout the day. Wind speed and direction affected dust controls and prompted additional health and safety measures, including work stoppages.

2.3 PREVIOUS INVESTIGATIONS

Previous investigations have identified radioactive materials and chemical contaminants in Parcels E and E-2. These investigations include the Parcel E Remedial Investigation (RI) (Tetra Tech EM, Inc. [TtEMI] et al., 1997), IR-02 radiological investigations, and regular groundwater sampling performed as part of the base-wide groundwater monitoring program.

The following investigations were performed prior to the TCRA:

- 1992 – Phase I radiological investigation
- 1993 – Phase II subsurface radiological investigation
- 1997 – Remedial investigation

Phase I investigation, completed in 1992 and known as the Surface Confirmation Radiation Survey (SCRS), was performed to detect elevated gamma radiation activity. The SCRS included a systematic screening of portions of IR-02 and other sites using surface gamma radiation surveys, soil sampling and analysis, downwell gamma radiation logging, and high-volume air sampling to establish the concentration of airborne radioactive particulates.

A 1993 Phase II subsurface radiation investigation consisted of trenching, excavating test pits, and downhole gamma logging to identify the subsurface extent of radium-containing material. Thirty-four test pits and three trenches were excavated within IR-02. In Parcel E, a total of five air permeability corings were collected, and 22 groundwater monitoring wells were logged for gamma activity.

Results of these investigations are summarized in Section 2.4.

2.4 NATURE AND EXTENT OF CONTAMINATION

This section details both the chemical and radiological analysis of the previous investigations discussed in Section 2.3.

2.4.1 Chemical Contamination

Groundwater in the A-aquifer at IR-02 exhibits total dissolved solids (TDS) concentrations ranging from 1,190 to 29,700 milligram per liter (mg/L) and salinity concentrations ranging from 0.77 to 18 parts per thousand (ppt). Groundwater in the B-aquifer exhibits TDS concentrations ranging from 5,400 to 6,010 mg/L. Chemicals of concern (COCs) in groundwater include metals and pesticides (TtEMI et al., 1997; TtEMI, 1998).

Chemical constituents detected in soil at IR-02 were compared to the following screening criteria: EPA, Region IX, preliminary remediation goals (PRGs) for metals and organic compounds, Hunters Point ambient levels for metals, and the HPS-specific criteria for petroleum hydrocarbons as defined in the RI. The RI concluded that the following constituents are present in the soil at concentrations exceeding their screening criteria (Figure 2-1):

- Metals
- Volatile organic compounds (VOCs)
- Semivolatile organic compounds (SVOCs), including polynuclear aromatic hydrocarbons (PAHs)
- Pesticides
- Polychlorinated biphenyls (PCBs)
- Petroleum hydrocarbons

The metals detected in soil samples at concentrations exceeding the screening criteria include antimony, arsenic, barium, beryllium, cadmium, chromium, hexavalent chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, selenium, silver, vanadium, and zinc as summarized in Table 2-1.

Additionally, vinyl chloride was detected in soil at 26 micrograms per kilogram (µg/kg), a concentration exceeding the EPA, Region IX, PRG of 5 µg/kg, in one of 87 soil samples. SVOCs detected in soil samples at concentrations exceeding the screening criteria include benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, and indeno(1,2,3-cd)pyrene.

Pesticides and PCBs detected in soil samples at concentrations exceeding the screening criteria include aldrin, Aroclor 1254, and Aroclor 1260 as summarized in Table 2-2.

Petroleum hydrocarbons detected at concentrations exceeding the screening criteria consist of total petroleum hydrocarbons (TPH) quantified as gasoline (TPH-g), TPH quantified as diesel (TPH-d), total oil and grease (TOG), total purgeable petroleum hydrocarbons (TPH-purgeable), and total extractable petroleum hydrocarbons (TPH-extractable) as summarized in Table 2-3.

The source and nature of chemical contamination at IR-02 is likely associated with undocumented fill practices and historic waste disposal activities.

2.4.2 Radiological Contamination

The SCRS identified over 300 radium-containing devices in the surface soil within IR-02, and concluded that radium-containing materials were present in surface soils in concentrations above those expected for normal background levels. The results also indicated that no mixed fission products were present in soils sampled in IR-02. Radioisotopes, other than ^{226}Ra, were within expected background levels in soil samples.

The Phase II investigation identified 111 radioactive, subsurface gamma-emitting devices within IR-02. These devices were found to a maximum depth of 9 feet, in an area measuring approximately 400 feet long by 250 feet wide. The radium-containing devices included illuminators, ship instruments, and dials, each with an approximate activity of 1 microcurie (μCi). As elevated gamma count rates were detected in the excavation spoils pile during trenching and test pit excavation activities, the devices were identified, if possible, and removed. The Phase II investigation concluded that approximately 85.6 percent of the 111 radioactive devices were found at depths ranging from 6.5 feet bgs to ground surface. The remainder of the devices was found to be distributed from 6.5 feet bgs to Bay Mud, with the majority at 10 feet bgs or above. No point sources or elevated gamma rates were found after Bay Mud was encountered.

The Phase II radiological investigation estimated the in-place volume of soil directly impacted by radioactive devices as approximately 5,500 cubic yards. The investigation also concluded that radium-containing materials were not placed in an excavated trench and covered with soil. Instead, the devices were disposed of with other material, and there is no clear association between soil stratigraphy and the location of gamma-emitting anomalies.

Figure 2-2 shows the results from the radiological investigations at IR-02. Radioactive source material, such as radioluminescent devices, was removed from IR-02 as it was discovered during the Phase I and II radiological investigations.

2.5 ACTION MEMORANDUM

The TCRA at IR-02 was conducted pursuant to the AM (DON, 2001a), which documented, for the Administrative Record, the DON's decision to undertake the TCRA at the site due to radioactive contamination in soils and debris. The AM (DON, 2001a) presented the regulatory framework under which the TCRA was performed, RROs, and specific remedial activities for the TCRA. The RROs were modified during the execution of the TCRA to correspond with the lower release criteria as presented in the revised AM (Tetra Tech EC, Inc. [TtEC], 2006).

2.5.1 Radiological Remedial Objectives and Release Criteria

The cleanup goals for buildings, structures, material, and land areas at HPS are listed in Table 2-4. Release criteria for equipment and material are taken from Atomic Energy Commission (AEC) Regulatory Guide 1.86 (AEC, 1974). Cleanup goals for soils are taken from the criteria established in the revised AM (TtEC, 2006).

2.5.2 DCGL Modeling

The intent of this report is not to achieve unrestricted release for IR-02. Per the AM (DON, 2001a), the goal of this TCRA with regard to radiological contaminants was to implement the AM (DON, 2001a) and protect public health and welfare and the environment by physically removing and disposing of radioactive contamination that exceed the RROs presented in Table 2-4. The RROs were developed through modeling and thus no further modeling is needed.

3.0 PRE-EXCAVATION ACTIVITIES

This section presents the pre-excavation activities conducted at IR-02. Pre-excavation activities included environmental resources surveying, pre-mobilization conference, field mobilization, initial radiological surface screening, site support area preparation, utility survey, environmental protection measures, stormwater and erosion control, and fugitive dust control.

3.1 PERMITTING

The DON submitted all necessary notifications prior to mobilization. Local permits were not required because the TCRA was performed in accordance with Section 121(e) of CERCLA. However, the substantive requirements for the local permits were met.

3.2 ENVIRONMENTAL RESOURCES SURVEYING

In 2004, preliminary investigations were performed within Parcel E to determine the presence of habitat for plant and wildlife species protected under the Migratory Bird Treaty Act, California Fish and Game Code, and state and federal Endangered Species Acts (ESAs). At that time, Parcel E had not been subdivided into Parcels E and E-2. Findings of these preliminary investigations are presented in the *Final Biological Assessment* (BA) (Tetra Tech FW, Inc. [TtFW], 2004a), which was conducted to evaluate potential for and mitigate against ecological impacts associated with three concurrent TCRAs executed within the boundaries of Parcel E and E-2, including IR-02.

The BA (TtFW, 2004a) identified eight ESA federally protected species, including four fish, three avian species, and one mammalian species as having the potential to be found in the vicinity of the TCRA project areas. Although the preliminary investigations determined that the removal actions were not likely to affect the eight ESA protected species, potential habitat, albeit marginal to submarginal, existed within the vicinity of the project area. Project activities were not deemed to have a critical impact on habitat for the protected species. Therefore, in the unlikely scenario that any of the eight ESA species were detected during project implementation, the BA (TtFW, 2004a) stated that a biological monitor would be on site during intrusive site activities, mobilization, and demobilization.

In accordance with the BA (TtFW, 2004a) and the Work Plan (TtEC, 2005), prior to mobilization, a qualified wildlife biologist performed an environmental resources survey. The environmental resources survey was conducted in March 2005. The survey identified no special-status species residing within the limits of work. As a precautionary measure, a wildlife biologist remained on site during intrusive activities. During the course of the field work, there were two killdeer nests identified at the site. One was within the excavation area and one was on the soil stockpile pad. An exclusion zone was established around both to protect the birds and their nests.

Once the eggs hatched, both birds left their nests in IR-02. No other sightings of ESA-protected species or biological issues were identified during excavation activities.

3.3 PRE-MOBILIZATION CONFERENCE

Prior to mobilization, a Kick-off Meeting was held on March 23, 2005, for the three TCRAs that were to be executed concurrently in Parcels E and E-2 at HPS, namely PCB Hot Spot, IR-02, and Metal Debris Reef/Metal Slag Area (MDR/MSA). The attendees included DON and TtEC personnel, as well as pertinent subcontractors and their project managers. During the kick-off meeting, site-specific activities and tasks required for the TCRAs were reviewed. Pre-construction mobilization requirements were validated prior to initiation of the TCRA fieldwork. The meeting agenda is included in Appendix B.

Prior to the kick-off meeting, and in accordance with TtEC policies, TtEC held an internal operational readiness review on April 5, 2005, with all pertinent TtEC employees and subcontractor representatives. This meeting included a review of health and safety, project, and waste management procedures for the project activities. Additional follow-up meetings were conducted during the course of the project as necessary, specifically after periods of inactivity in the field, or when new procedures were developed.

Prior to commencement of mobilization activities, base entry badges for employees were obtained by delivering a list of field personnel to SFRA. To obtain required vehicle decals, a list of personally owned vehicles, along with the required insurance and registration documentation, were provided to the HPS Police Department.

3.4 RADIOLOGICAL SURFACE SCREENING

Prior to mobilization of heavy equipment, an initial radiological surface survey of IR-02 was completed. The area of the survey extended beyond the excavation area and included all laydown areas. The purpose of the radiological surface survey was to identify surface and near-surface (to a depth of 30.5 centimeter [cm], 12-inch [in] bgs) radioactive materials for removal prior to excavation activities to prevent the spread of contamination by the project equipment. This depth is based on the capability of the survey instrumentation.

The preliminary radiological surface survey consisted of a high-density gamma scan performed over a 50-foot by 50-foot grid system with the use of sodium iodine detectors supported by global positioning system (GPS) equipment for locations. The high-density survey process resulted in a 100 percent scan survey. Once suspected radioactive material was confirmed, GPS/grid coordinates were recorded and the location marked or flagged. Radiological support personnel then removed the radioactive material, including the soils from within 1 foot in all directions of the material, from the marked location using a small backhoe fitted with a smooth blade bucket and/or hand-digging tools. Follow-up surveys were performed to confirm the removal of the radioactive materials. This method was followed until all radiological materials identified during the initial radiological surface survey were removed.

For additional information regarding the removal of identified radiological materials and a summary of radiological findings see Section 4.0.

3.5 SITE SUPPORT AREA PREPARATION

Prior to the mobilization of equipment and materials to IR-02, project support areas were established to provide for the temporary storage of tools, equipment, and materials. Support areas were also established outside the fenced-in area of each site to provide employee vehicle parking and break areas.

3.6 MOBILIZATION

Mobilization activities included site preparation, movement of equipment and materials to the site, a topographic survey, and orientation and training of field personnel. Throughout the months leading up to field mobilization, representatives from the Resident Officer in Charge of Construction (ROICC), the RASO, and the Caretaker Site Office and the DON Remedial Project Manager (RPM) were notified regarding the planned schedule and commencement of ground-breaking excavation activities.

Upon receipt of the appropriate records and authorizations, field personnel, temporary facilities, and required construction materials were mobilized to IR-02. The temporary facilities included restrooms, security fencing, runoff controls, and secure Connex storage boxes for short- and long-term storage of materials. Construction materials mobilized to the site allowed for the building of the lined dewatering/radiological screening pad, large debris holding pad, low-level radioactive waste (LLRW) and low-level mixed waste (LLMW) holding pad, stockpile pad, equipment decontamination pad, and soil dewatering pad.

Prior to mobilizing heavy equipment to the area, the entire surface within the work area (including excavation and laydown areas) was screened for gamma-emitting radioactive sources, as described in Section 3.4. To facilitate this, vegetation at IR-02 was cleared and grubbed before screening started.

Once the surface of the area was cleared of radiological materials, equipment mobilization was initiated and the entire construction area of IR-02 was enclosed with temporary 6-foot security fencing. A lined dewatering/radiological screening pad, large debris holding pad, LLRW and LLMW holding pad, stockpile pad, equipment decontamination pad, and soil dewatering pad were constructed using Bay Area Rapid Transit (BART) soil, rock (decontamination pad only), and a double-liner design as described in the Work Plan (TtEC, 2005). Additionally, the dewatering and the decontamination pad had sumps to collect runoff water. The site layout is presented in Figure 3-1.

Stormwater controls addressing appropriate best management practices (BMPs) were installed around the pads. The stormwater controls were implemented in accordance with the Stormwater Pollution Prevention Plan (SWPPP) in the Work Plan (TtEC, 2005).

Incoming equipment and material were subject to the following:

- Equipment and material were surveyed for existing contamination levels prior to being placed into service.
- Surveys consisted of a 100 percent scan of accessible areas for fixed alpha/beta emitters. Swipes were taken to ensure that no loose contaminants were present. No survey results exceeded the RROs listed in Table 2-4; therefore, the equipment was placed into service.

3.7 UTILITY SURVEY

Topographic geophysics surveys, landside geophysics surveys, and downhole geophysics were conducted as part of the additional site characterization conducted in July 2004. Additionally, existing as-built drawings of the area surrounding IR-02 were reviewed. The results of the additional site characterization survey activities were compared to the available as-built drawings to determine the utilities present. Identified underground features within the vicinity of the proposed excavation areas were marked using appropriately colored paints, stakes, and flags.

3.8 ENVIRONMENTAL PROTECTION MEASURES

The Environmental Protection Plan (EPP) (Section 8.0 of the Work Plan [TtEC, 2005]) was implemented during project activities. The EPP outlined the environmental compliance procedures and regulatory, procedural, and training requirements for conducting the TCRA field activities. Applicable or relevant and appropriate requirements pertaining to hazardous waste management, air emissions, stormwater, fugitive dust, floodplains, wetlands, and endangered species were also identified in the EPP along with required control measures.

The SWPPP (Appendix C of the Work Plan [TtEC, 2005]) was implemented during project activities. The SWPPP addressed the appropriate BMPs for controlling stormwater at MDR/MSA. The SWPPP was developed in accordance with State Water Resources Control Board requirements. Due to the fact that the field activities were regulated under CERCLA, a general National Pollutant Discharge Elimination System (NPDES) stormwater construction permit was not required, although the substantive requirements of the NPDES permit were met.

3.8.1 Best Management Practices

Prior to site activities, a sandbag berm and silt fence were installed along the perimeter of IR-02 to prevent stormwater on the contaminated portion of the site from leaving the site, as well as to prevent stormwater run-on from areas outside of the site. In addition, stormwater measures were placed along the exterior of the excavation footprint and the perimeter of the screening and stockpile areas.

Excavation activities were only conducted in the immediate area when dry weather was forecast. Sandbags were placed as needed in drainage control swales and at drainage control discharge points or areas with high probability of erosion. Additional sediment control such as silt barriers or hay bales, encased in silt fencing, were used as well.

Additionally, all pads were constructed utilizing BMPs (including hay bales and sandbags) around the exterior edge to limit stormwater from running off the pad without being collected.

4.0 EXCAVATION AND INVESTIGATION ACTIVITIES

This section presents the excavation activities that were conducted. Excavation activities included soil and debris excavation, removal, and screening.

4.1 EXCAVATION OF CONTAMINATED SOIL

Excavation at IR-02 began in May 2005 once mobilization was complete. The excavation at IR-02 was completed in October 2006.

The original IR-02 excavation boundary in the Work Plan (TtEC, 2005) included an area of approximately 2.99 acres in size (Figure 3-1). The excavation boundary at IR-02 was not modified or extended during excavation activities. A 50-foot by 50-foot grid system was surveyed and established across the excavation areas. The grid system was marked in the field and was used to track the required radiological surface surveying within the excavation boundary, control and record excavation progress, and assist in locating post-excavation samples.

After the radiological surface survey was complete, material within the boundaries of the IR-02 that was above groundwater was excavated in 30.5 cm (12-in) lifts. Each of these lifts was surveyed in situ prior to excavation to identify and allow removal of radioactive material. Some areas were excavated in 15 cm (6-in) lifts due to extensive radiological contamination being found. This allowed for radioactively contaminated soil to be segregated for disposal prior to being placed into trucks for transport to the secondary screening area. Below groundwater, the entire soil column, including material and debris, was removed to the bottom of the excavation without surveying individual lifts, since surveying below the water surface is not effective. Discrete sampling was still performed as described in Section 4.11..

IR-02 had two material screening areas, conveyors one and two (Figure 3-1). These areas were located on a temporary pad encompassing a dewatering/screening pad and a large debris pad. In addition, a large staging area was used to store large debris, processed soil, and LLRW.

Approximately 49,000 cubic yards of material was excavated from IR-02. Most excavated material was processed through the conveyors; large debris was segregated and moved to a separate screening pad. Prior to screening the excavated material, firebricks were manually removed and stored in a separate staging area. Firebricks were segregated because they contain naturally occurring radioactive materials and require special disposal. The dewatering/screening pads were designed to manage approximately 50 cy (four separate truckloads) of excavated material at one time with sufficient area for heavy equipment to maneuver safely. The large debris pads were sized to manage approximately 15 cy of material at a time plus sufficient space for heavy equipment to maneuver safely.

When wet/saturated material was encountered in the excavation, the material was stockpiled in the excavation, allowed to drain for 1-2 days and then transported to the dewatering pad and allowed to dewater further. If necessary an excavator was used to work the material to increase evaporation. Once the material was dry enough, it was run through the conveyors. Radioactive material identified during screening activities was collected, segregated, and stored in appropriate containers for subsequent disposal under the direction of the Army LLRW Disposal Program.

Material processed through the conveyor systems was deposited in piles of approximately 100 cy at a rate of 1 ft per second. Two radiological samples were drawn from each of these piles from random locations. If the results from these samples were above action levels, then the 100 cy pile was subdivided into eight equal-sized piles. Two additional samples were drawn from each of the smaller piles. The small piles where the samples exceeded action levels were placed into bins for disposal. Those piles with sample results that did not exceed the action level were placed on the appropriate stockpile.

The samples were analyzed in the on-site radiological laboratory by gamma spectroscopy prior to moving the soil. Radiologically contaminated material identified during surveys or sample analysis was placed in storage containers at the originating site pending appropriate disposal. Water from the dewatering/screening pads was collected, characterized for chemical and radiological constituents, and properly disposed. Wastewater sampling was conducted according to the procedures and frequency detailed in the *Final Sampling and Analysis Plan for IR-02, Parcel E* (Sampling and Analysis Plan [SAP]) in the Work Plan (TtEC, 2005). Radioactive Material Management was performed in accordance with the requirements of New World Technologies, Inc.'s Nuclear Regulatory Commission (NRC) license.

Excavated material on the large debris pads was also screened manually for alpha and beta/gamma emitters. Radiologically contaminated material identified during debris screening was stored at the originating site pending proper disposal.

Radiologically released excavated soil and material was stockpiled at the appropriate pad at IR-02. This soil was then further characterized to support off-site disposal or use as backfill for the excavation. These samples were analyzed at an off-site laboratory. Trucks transporting these non-radiological wastes passed through the on-site portal monitor prior to exiting HPS. Quantities of material shipped and remaining are detailed in Section 6.0.

Stockpiles were managed in accordance with the SWPPP (Appendix C in the Work Plan [TtEC, 2005]) and sampled for laboratory analysis in accordance with the SAP (Appendix A in the Work Plan [TtEC, 2005]), pending subsequent disposal. Large debris that was radiologically released was placed in roll-off bins for transportation to and disposal at a CERCLA Off-site, Rule-approved landfill.

To minimize potential worker exposure to, and spread of, contamination during excavation, screening, and stockpiling, dust suppression measures were implemented. Air monitoring for radiological constituents was performed. Other chemicals of concern, such as PCBs, particulates and metals, were monitored as necessary for health and safety purposes to confirm the effectiveness of these measures per the Site Health and Safety Plan (SHSP). Water compliance monitoring during excavation activities was also conducted.

4.2 BURIED DRUMS, BOTTLES, JARS, AND CONTAINERS WITH UNKNOWN CONTENT

During the course of excavation activities, drums, bottles, jars, and containers were encountered within the site. A written procedure for handling buried drums, jars, and containers with unknown content was developed and implemented (see FCR-IR-02-036 in Appendix J) outlining the requirements for safe excavation, removal, handling, and sampling of any such unearthed items. See Section 6.0 for a detailed account of drums, bottles, jars, etc. that were removed during excavation. Many of the bottles, jars, and containers encountered were not identified until the soil was spread out on the pads or being run through the conveyors.

4.3 MATERIALS POTENTIALLY PRESENTING AN EXPLOSIVE HAZARD

During intrusive work activities at IR-02, a TtEC UXO technician was on site in case a suspect item thought to be materials potentially presenting an explosive hazard (MPPEH) was encountered. All work executed by the TtEC UXO technician was performed in accordance with the Op-5, Volume 1 (NAVSEA, 2005).

Personnel assigned to work at IR-02, including subcontractor personnel, were required to attend a training session on the identification of possible MPPEH items and the procedures to follow once a suspect item was identified. In addition, prior to the start of work activities each day, a daily UXO safety briefing was given, in addition to the normal safety briefing.

MPPEH was defined as any component of ordnance or explosive munitions that may have come into contact with energetic material (i.e., high explosives or propellant) and could have energetic residue remaining. Examples of MPPEH encountered during the project included expended cartridge casings of various calibers, projectiles of various calibers, and 5-inch projectile protective caps. In total, there were 134 MPPEH items encountered at IR-02 as presented in Table 4-1. Many of the MPPEH items encountered were not identified until the soil was on the pads or being run through the conveyors.

During the course of the project, MPPEH identified by the TtEC UXO technicians was labeled with a numerical identification number, photographed, and placed into a labeled, 55-gallon drum for temporary storage on HPS. The items encountered were labeled and stored using two categories: 1) 3X (possibly contains an explosive hazard) and 2) 5X (contains no hazards). The information was then entered into the Acquisition and Accountability Log for tracking. The Acquisition and Accountability Log is maintained in the project files. At the end of each work day, the drum was sealed. The drums used for storage of collected MPPEH were located at Building 704. All but 3 MPPEH items were radiologically released after surveys were performed by Radiological Control Technicians (RCTs) under the supervision of UXO technicians.

Upon completion of all work activities by TtEC in Parcel E and E-2, items encountered will be re-inspected by UXO technicians for possible explosive hazards. The items certified as being safe will be demilitarized (crushed, burnt, cut, etc.). The remaining items of unknown condition will be treated to neutralize the possible explosive hazard and then also demilitarized. Upon demilitarization, all items will then be certified as safe to ship and turned over for scrap. This action is still pending.

4.4 WELL DESTRUCTION

During the course of the TCRA, four groundwater monitoring wells at IR-02 (IR02MWB-3, IR02MW-127B, IR02MW-141A, and IR02MW-372A) had to be destroyed. The wells were destroyed on June 6 and 7, 2005. The destruction of the wells was completed in a manner consistent with the specifications outlined by the California Department of Water Resources (1991) and the Work Plan (TtEC, 2005). Well destruction forms for the wells are included in Appendix C.

4.5 FUGITIVE DUST CONTROL

Aggressive dust control measures were used during excavation at IR-02. Continuous air monitoring was performed during intrusive excavation activities. Additionally, the wind speed was constantly monitored and if wind speeds exceeded 25 miles per hour, excavation and soil handling were discontinued. Appendix A contains weather data from the on-site weather station including wind speed and direction. Dust-control measures included dust suppression, covering of stockpiles with ten-thousandths of an inch (mil) liner, and ceasing activities when wind speeds were high. A water truck or water tank equipped with a hose to mist the soil and debris during excavation, segregation, and screening activities was used for dust-suppression activities.

Air monitoring during excavation, segregation, and screening activities included analyses for total suspended solids, particulate matter, PCBs, asbestos, and radionuclides of concern (ROCs). Field operations were conducted to minimize airborne dust and stay below the derived airborne concentrations in Table 4-2 as much as possible. The air monitoring data were combined with the weather data collected to ensure the safety of the site workers and the public in the area surrounding HPS. A stand-alone report detailing air monitoring results will be submitted by the air monitoring subcontractor in summer 2007.

4.6 INSTRUMENTATION FOR RADIOLOGICAL SURVEYS

In support of the radiological control objectives for this TCRA, various instruments were used to detect the radioactive material known or suspected to be present within IR-02. The instruments and measurement methods were selected for their ability to detect the ROCs or radiation types of interest, and capability of measuring levels sufficient to support the Data Quality Objectives (DQOs) when used with the appropriate survey or analytical technique. Table 4-3 identifies the instrumentation used for radiological surveys.

4.7 RADIOLOGICAL SURVEYS AND POST-EXCAVATION SAMPLING APPROACH AND RESULTS

The RAO for this TCRA was to implement the AM (DON, 2001a) and protect public health and welfare and the environment by physically removing and disposing of radioactive contamination that exceed the radiological remedial objectives presented in Table 2-4. The ROA was implemented by a.) Identification and removal of discrete radioactive materials (point sources), and b.) Identification and removal of sources of radioactivity not readily identifiable as a point source. Once the final depths of excavation had been achieved, post-excavation chemical characterization samples were collected at the bottom of the excavation for use as part of the remedy evaluation and selection process.

4.8 SURVEYING AND SAMPLING DURING EXCAVATION

After removal of each lift, the in-situ soil was surveyed with a high density gamma scan to identify and allow removal of any radioactive materials that may have been present. If radioactive material was noted, the area indicated was further excavated and re-scanned to confirm complete removal.

Excavated soil and debris underwent secondary radiological screening at one of two screening conveyor systems located on the dewatering pad at IR-02. Material went through a vibrating grizzly and then was screened through a conveyor to separate soil from small debris. Segregated debris was transported to the laydown area for radiological screening. Soil passed through the grizzly and was fed through a conveyor belt equipped with an array of gamma/beta detectors, where secondary ex-situ screening was performed to identify radioactively contaminated material. Sprinklers/misters were installed along the catwalk of the conveyor system for dust-suppression purposes.

The conveyor system featured a Ludlum Model 4612 12-channel single channel analyzer controlled by a laptop computer, which used the Ludlum Model 4612, Version 1.3.3 software for analysis. The instrument was equipped with six Ludlum Model 44-10 and six Ludlum Model 44-40 detectors. The Model 44-10 detectors were positioned less than 8 inches in height above the surface of the conveyor belt, while the Model 44-40 detectors were positioned less than 6 inches in height above the surface of the conveyor belt. The detectors were positioned across the conveyor belt to ensure complete beta/gamma radiation screening of conveyor-processed materials. Radiation detection instrumentation was programmed with individual alarm trip points for each detector of 3 standard deviations (3 sigma) above the average background level, which allowed the conveyor system to be immediately shut down should an alarm set-point value be exceeded. The depth of the soil under the detectors on the conveyor belt was approximately 2 to

4 inches. The conveyor system was setup to move the soil under the detector array at a rate of 1 foot per second. When the conveyor system was stopped due to the tripping of an alarm point, impacted soils were removed from the conveyor into an approved container. Any soil removed from the conveyor system due to an alarm trip was surveyed to identify any radioactive material or discrete point sources. When radioactive material was found, it was handled as radioactive waste. Soil removed from the conveyor due to the tripping of a preset alarm was sampled and placed into an appropriate container for subsequent characterization and disposal. In addition, three (3) feet of soil/debris from either side of where the radioactive material was located on the conveyor belt was also removed. If no radioactive materials were identified, 6 feet of soil were removed.

The conveyor system pad was lined with 20-mil high-density polyethylene or polyvinyl chloride liner and bermed to prevent surface water runoff and rainwater from contaminating clean soil outside of the containment area. A sump basin was installed in the pad area and any runoff water collected in the sump was pumped to a temporary storage tank with appropriate secondary containment to collect any leachate that accumulated in the sump. Collected runoff water was sampled, characterized, and disposed of as appropriate.

Large debris were manually surveyed for alpha and beta/gamma emitters, and then released if no contamination was found.

Water from the dewatering/screening pads was collected, characterized for chemical and radiological constituents, and properly disposed of. Wastewater sampling was conducted according to the procedures and frequency detailed in the SAP in the Work Plan (TtEC, 2005).

4.9 SCANNING MEASUREMENT TECHNIQUES

Supplemental surface scan surveys for gamma radiation were performed by traversing a path at a speed (scan rate) not exceeding 0.5 meters per second (1.6 feet per second), while maintaining the detector approximately 10 cm (4 in) above the area being surveyed. Additional radiological surveys were performed on the material as it went through the conveyors.

All gamma scans are performed in accordance with the HPS Standard Operating Procedure (SOP) HPO-Tt-006 (TtFW, 2005b) Radiation and Contamination Surveys. The investigation level for gamma surveys was established as the reference area mean + 3σ, where σ is the standard deviation of the gamma readings in the reference area. All survey data were reviewed by the Radiation Safety Officer (RSO) to identify any trends or in cases where the investigation level was exceeded to determine required supplemental surveys.

Where practicable, scan surveys for gamma radiation were performed using a towed array system consisting of four arrays of three Ludlum Model 44-10 scintillation detectors spaced 30.5 cm (or 12 in) apart connected to a Ludlum 4612, 12 detector single channel analyzer and a GPS receiver to correlate logged data points to specific coordinates. In cases where the towed array could not be used, surveys were performed by hand by an RCT using a Ludlum Model

2350-1 data logger equipped with a Ludlum Model 44-10 2-inch by 2-inch NaI scintillation detector (or equivalent). Areas that contained Bay Mud, other obstacles or were below groundwater level were not surveyed. Any radioactive material identified by scan surveys was removed, segregated, packaged separately, stored, transported off site, and disposed of as LLRW.

4.10 SYSTEMATIC GRIDS

Each excavation boundary footprint was also divided into a series of systematic grids, each not exceeding 2000 square meters (m^2) (approximately 2,400 square yards [yd^2]) in each area. Each systematic grid was given a numerical designation. A total of 10 systematic grids were used at IR-02 Northwest and Central. Figure 4-3 shows the radiological sampling grids for IR-02 Northwest and Central.

4.11 POST-EXCAVATION SURVEYING AND SAMPLING

Post-excavation surveying and sampling consisted of sample collection from grid locations within survey units. Sidewalls and excavation bottom of each grid were first surveyed upon completion of excavation, and then re-surveyed prior to sampling to aid in determining biased sampling locations.

High-density gamma scans were performed over the excavated bottom and perimeter sidewalls using a towed array mechanism, supplemented by handheld detectors. Each grid cell was scanned using a Ludlum Model 4612 instrument that features a single channel analyzer assembly equipped with a programmable computer that streamlines all operation parameters. Four arrays of three Ludlum Model 44-10 scintillation detectors spaced 12 inches apart are connected to the Ludlum 4612. The Ludlum 4612 was connected to a GPS receiver which was used to correlate logged data points to specific coordinates. This instrument array was positioned behind the back of a tow vehicle so as to "follow behind" the path of the vehicle. Survey lanes are approximately 1 meter wide.

Supplemental gamma scans and static measurements were also performed using Ludlum Model 44-10 2 inch × 2 inch Sodium-Iodide (NaI) scintillation detectors coupled to Ludlum Model 2350-1 data loggers. The gamma scans were performed in accordance with the HPS SOP HPO-Tt-006 (TtFW, 2005b). The scan surveys were performed at a rate of approximately 0.08 meters per second with the detector held approximately 10 cm (4 inches) from the surface. Investigation levels for gamma radiation surveys were background plus 3 standard deviations above the mean. The background reference area was established in a non-impacted area of Parcel E.

All 59 grids surveyed identified at least one measurement that exceeded the investigation level. Several of the grids contained numerous measurements exceeding the investigation level. Since the excavation limits had been reached, the Navy made a decision to remove hot spots that were identified to exceed 15,000 cpm gamma. Of the 59 grids surveyed, 27 grids had additional radioactive materials removed prior to sampling. Table 4-4 lists the grids, associated towed array measurement, follow-up static measurements, depth of removal action, and final static measurement. Some of the grids that had hot spots identified were underwater which did not allow any follow-up removal actions. Final scan data from grids that were not under water are presented in Appendix G.

Once the hot spots were removed and confirmation of the effectiveness was obtained using field instrumentation, the grid was then ready for both chemical and radiological sampling.

Two different types of post-excavation samples were collected – random and systematic.

Randomly located post-excavation samples for radiological analysis were collected within each 50-foot by 50-foot grid cell of the excavation bottom, and one random sample from every 50 linear feet of perimeter sidewall. An additional 9 biased sidewall samples were collected based on review of the scan data.

Systematically located post-excavation samples were collected at a rate of sixteen per survey unit. The IR-02 excavation boundary was divided into ten 2,000 m^2 (approximately 2,400 yd^2) survey units. Further, a 100 percent high-density gamma scan was performed at the vertical excavation limit to further identify if any additional discrete gamma-emitting sources were present. These scans were completed in areas that were not fully saturated with water.

Random and systematic samples were analyzed for gamma-emitting radionuclides by the on-site radiological laboratory. Individual gamma spectroscopy reports for the post-excavation sampling can be found in Appendix H.

Ten percent of the samples were randomly selected to be sent to an off-site radiological laboratory for gamma spectroscopy analysis for QA purposes. Data from the on-site and off-site gamma spectroscopy analysis was compared. In addition, 30 percent of the samples were analyzed for ^{90}Sr by the off-site laboratory. Tables 4-5 through 4-7 present the post-excavation on-site and off-site radiological lab data comparison. Individual off-site laboratory sample data can be found in Appendix M.

4.12 RADIOLOGICAL POST-EXCAVATION SURVEY RESULTS

Results of on-site and off-site sample analysis for all post-excavation radiological samples are presented in Appendix H. The results are presented in a graphical format as well as simple numerical values. Areas where RROs were exceeded were highlighted.

A few samples collected from random and systematic locations at the bottom of the IR-02 excavation showed activity near or above the RROs. See section 9.4.1 for a discussion of specific samples exceeding the RROs. As this was not a final status survey and no statistical analyses were performed, there is no prescribed method to confirm the validity of a given elevated reading. In a manner consistent with chemical analyses, when an elevated area was identified for a given sample, the results of complementary sample analysis (i.e., off-site analysis), if available, were scrutinized. In the absence of complementary analysis, the results of other samples taken from the same base grid were compared. When this approach was employed there were no cases where multiple samples for a given grid showed elevated activity. Knowing that surface scans were also performed, it is reasonable to assume that an isolated point source above the groundwater level would have been identified and removed during the surface scan. Therefore, it is believed that the limited detections in sidewall and bottom samples are likely indicative of contamination beyond the boundaries of the excavation.

4.13 CHEMICAL POST-EXCAVATION SURVEY RESULTS

Chemical post-excavation samples had detections of residual PCBs, PAHs, metals, and TPH above screening criteria. Chemical post-excavation sample results are presented in Appendix D and sample locations are presented on Figure 4-4. These results will be used in the Draft Revised RI Report for Parcel E and in the Draft RI and FS Report for Parcel E-2.

4.14 CHEMICAL STOCKPILE SAMPLING – BACKFILL MATERIAL

Soil stockpiles generated during excavation activities not containing radioactive contaminants, radioactively contaminated materials (including LLMW), or discrete radioactive point sources was sampled for a number of chemical constituents prior to use as backfill in the excavation. Material that exhibited obvious staining or odor was sampled, but not used as backfill as described in Section 6.1.

Soil samples were collected from this material at a frequency of one sample per 500 cubic yards. A minimum of five samples were collected from any stockpile smaller than 2,500 cubic yards. The samples were sent to an off-site laboratory and analyzed for VOCs; SVOCs, including PAHs; pesticides; PCBs; TPH-extractable; and Title 22 metals. Asbestos, Soluble Threshold Limit Concentration (STLC), and Toxicity Characteristic Leaching Procedure (TCLP) were added as applicable. Radiological analyses were not performed on these samples because this soil was evaluated for radiological contamination before being stockpiled. The results from the characterization sampling are included in Appendix E.

4.15 GEOPHYSICAL SURVEY

Following the completion of the excavation, a geophysical investigation of the excavation bottom was conducted. The purpose of this investigation was to map any residual metal. The geophysical survey was completed on December 2, 2006.

Much of the excavation footprint was submerged at the completion depth of the excavation. Clean import fill material was placed in the submerged areas to bridge the water which was intended to prevent the tidally influenced groundwater from coming into contact with processed soil that was going to be returned to the excavation. A coincidental benefit for the geophysical investigation is that this backfill significantly enlarged the accessible footprint within the excavation.

A Geonics EM61 MK 2 Time Domain Electromagnetic metal detector was used for this survey. This instrument detects both ferrous and non-ferrous metals. Positioning of the geophysical data was accomplished using a Differential Global Positioning System (DGPS). A two-person crew was used to carry the instrumentation; the front person carried the EM61 coil and DGPS antenna using a purpose-made harness.

Geophysical and positioning data were collected over the accessible part of the excavation bottom. Data was acquired along survey lines spaced 10 feet apart. The EM61 was set to record at 12–15 readings/second resulting in a reading approximately every 0.25 feet along each of the survey transects.

The contour image (Figure 4-5) shows the geophysical response, in millivolts; the higher amplitude colors (yellow, orange, red, pink) are indicative of subsurface metal. The green and blue colors represent a lower amplitude response and are characteristic of where the Bay Mud was visible, or very near the surface.

The area southwest of the dark-blue colored line on the figure contains numerous high-amplitude targets. The amplitude of the response over this area would be consistent with the type of debris encountered during the excavation, including wire rope, metal plate, and miscellaneous metal debris.

To the northeast of the dark-blue colored line, the data has a characteristically low amplitude response. At the conclusion of the excavation, much of this area was submerged. During the survey, most of the submerged area was covered with clean import material and the remainder was exposed Bay Mud. The geophysical response over this area varies only slightly. This suggests that there are no remaining large concentrations of residual metal on the Bay Mud surface, and that the Bay Mud was not placed as a cap over other waste.

The geophysical results are consistent with the findings of two test pits that were completed into the Bay Mud. Each of the test pits was completed to approximately 10 feet bgs. Throughout the Bay Mud, there was no evidence of man-made material.

The approximate footprint of the Bay Mud has been outlined with a solid/dashed red line on Figures 4-1 and 4-5. The solid line represents where the Bay Mud was visible; the dashed part of the line is where the Bay Mud was submerged at the total extent of the excavation.

5.0 POST-EXCAVATION AND INVESTIGATION ACTIVITIES

This section presents the post-excavation activities that were conducted. Post-excavation activities included backfill, compaction, grading, topographic survey, demobilization, and site restoration. This section also details field changes during the project and site inspections.

5.1 BACKFILL, COMPACTION, AND GRADING

Once post-excavation sampling of IR-02 had been completed, a layer of geotextile material was placed within the excavation and backfilling was performed. The geotextile material was placed over the entire bottom and sidewalls of the excavation. The purpose of the geotextile was to serve as a demarcation of the final excavation boundary.

Following placement of the geotextile material the excavation was backfilled with approximately 33,900 cy of excavated material that had been radiologically screened and released for use as backfill. Approximately 5,200 cy of clean imported material was placed to bridge standing water at the bottom of the excavation. Additionally, approximately 14,000 cy of radiologically sampled and cleared soil used as pad material were used as backfill. At a minimum, the top three feet of the excavation boundary was backfilled using clean import fill material. Import material was sampled prior to use in accordance with the SAP (Appendix A in the Work Plan [TtEC, 2005]). The backfill soil was placed in the excavation in layers. The soil that had been excavated from the site and radiologically screened and released for use as backfill was replaced in the excavation in the same order in which it was removed (Figures 5-1 through 5-3). All large debris was removed from the soil during excavation and it was not replaced in the excavation. Once the potential backfill source material was sampled, analytical results were reviewed as specified in the Work Plan (TtEC, 2005). The backfill used came from two sources, the Cow Palace Site and Mills Peninsula Hospital MPHILL. The Work Plan included requirements for chemical and radiological analyses for backfill material. The backfill soil sampling data for the backfill sources are presented in Appendix E.

Where possible, the backfill material was compacted by wheel or track rolling to a firm, unyielding condition and verified by the TtEC Field Engineer. No compaction testing was required.

5.2 TOPOGRAPHIC SURVEY

To allow comparison with the pre-excavation topographic survey (Figure 5-4), IR-02 was resurveyed following backfill and final grading (Figure 5-5). The figures document the pre- and post-excavation surface elevations. The surveys recorded the topographic conditions of the land area within the final IR-02 excavation boundary in sufficient detail to generate a topographic map with 1-foot elevation contour intervals.

The topographic survey included the establishment of transects spaced 25 to 50 feet apart, covering the entire site. Horizontal and vertical data were collected approximately every 10 feet and at major land breaks on these transects. The topographic survey was referenced to North American Datum 1927, California State Plane Zone 0403, in U.S. survey feet. The vertical data was referenced to National Geodetic Vertical Datum of 1929. Topographic survey, layout, and related work were performed by a Professional Land Surveyor registered in the state of California. The surveyor's report is included in Appendix H.

5.3 DEMOBILIZATION

In April 2007, backfill, compaction, and final grading of IR-02 was completed and demobilization activities were initiated. Demobilization included the decontamination and free-release surveying of construction equipment and materials, cleaning of the IR-02 project site, performing final radiological surface surveying of disturbed areas, and issuing a certification of completion. Demobilization activities also involved final collection and disposal of decontamination water.

Prior to removing equipment and materials from IR-02, chemical decontamination and radiological free-release surveying was completed. Before chemical decontamination of equipment took place, preliminary radiological surveys, consisting of a 100 percent scan of accessible areas for alpha/beta contamination, were conducted. If radioactive contamination above the established criteria was identified during the initial scans (as defined in Table 2-4), the contamination was removed using the appropriate decontamination SOP prior to chemical decontamination being initiated. Chemical decontamination of heavy equipment and materials was completed at the site decontamination pad located near the main site entrance/exit. Heavy brushes were used to remove soil and dirt attached to the equipment surfaces. Special attention was paid to removal of soil and dirt on and within the bucket, the tracks/tires, and undercarriage of the equipment. If dry decontamination practices were not sufficient, the soil residue was removed using low-pressure washing with water.

Following chemical decontamination, radiological free-release surveys consisting of surface scans and removable contamination swipe samples were performed by the radiological subcontractor prior to releasing any equipment to rental vendors. Hand tools used for radioactive material removal were surveyed for free-release. Radiological free-release surveys were documented by the radiological subcontractor and each piece of equipment received a unique survey number. All equipment used was eventually cleared of radioactive material and released back to the rental vendor.

Decontamination water was periodically pumped from the sump within the decontamination pad into an on-site wastewater collection tank and sampled. The collected decontamination water and other wastewater collected within the wastewater collection tank were sampled for radioactive constituents prior to being disposed of by using the on-site sanitary sewer under permit from the

San Francisco Public Utilities Commission, Bureau of Environmental Regulation and Management. A separate permit was obtained for each disposal event.

Demobilization also included site-cleaning activities. Site cleaning consisted of repairing erosion or runoff-related damage; grading all areas used for construction; and removing all excess construction material, wood, debris, and other foreign material from the site. Repairs to erosion or runoff-related damage included replacing and reinforcing hay bale and sandbag berms surrounding the lined stockpile pad areas and site perimeter. Areas outside IR-02 that had been disturbed during the removal action, including equipment- and debris-staging areas, were graded to remove rutting and provide proper drainage. Leftover trash, wood, debris, and other foreign materials were collected and segregated by type for proper off-site disposal.

Following the removal of all trash and debris, the ground surface within the unexcavated areas at IR-02, including padded laydown areas, was surveyed for gamma-emitting radionuclides using a towed array system, as described previously. Data obtained from the pre-mobilization initial land surface scan survey were compared to the data collected during the demobilization scan survey to ensure that radioactive materials were not relocated or additional radioactive contamination had not been introduced. Review of the final surface scan data identified 3 grids that have elevated measurements remaining. Grid 40 had one measurement at 89,000 counts per minute (cpm), grid 90 had one measurement at 10,000 cpm, and grid 175 had measurements of 10,000 and 24,000 cpm. No remedial action was taken or additional investigations performed in these areas.

5.4 SITE RESTORATION

Since backfill and grading, the Installation Restoration Site-02 Northwest and Central Area is undergoing natural revegetation. In addition, periodic visual inspections are performed to ensure appropriate drainage and storm water protection. In the event that supplemental revegetation is necessary in order to prevent excessive surface erosion, the option for hydroseeding the site will be re-evaluated.

5.5 FIELD CHANGES

To provide for a safer conduct of the field work, improve production, and meet the unexpected changes in site conditions the field change request (FCR) process was used to address unforeseen circumstances during the implementation of the TCRA. The FCR process is utilized when changes are requested by construction or other qualified personnel at the site. An FCR is used to document a change to the "as designed condition" and request or suggest a solution. The FCR process requires that any requested changes to project design specifications or plans be reviewed and approved by multiple technical specialists prior to implementation. During work at IR-02, a total of 19 FCRs were completed. All FCRs relating to radiological materials were pre-approved by the RASO before implementation. The HPS FCR Log and copies of the FCRs that affected work at IR-02 are provided in Appendix J.

5.6 COMPLETION INSPECTIONS

The Pre-Final Completion inspection will be performed as summarized below. The Pre-Final and Final Completion Inspections have not been performed to date.

5.6.1 Pre-Final Inspection

The purpose of the pre-final inspection is to identify punch list items that need to be completed prior to job end. An initial pre-final inspection has been performed; however the HPS ROICCs have requested CTO-wide, pre-final and final inspections, rather than site-specific inspections. The CTO-wide, pre-final inspection has not been completed as of the writing of this document.

5.6.2 Final Acceptance Inspection

The purpose of the final acceptance inspection is to verify that all specific items previously identified as incomplete or unacceptable during the pre-final inspection are completed and acceptable. As of the writing of this document, the Final Completion Inspection has not been completed.

5.7 PHOTOGRAPHIC LOG

Photographs of the site were obtained during the implementation of the TCRA activities. Photographs were taken during each aspect of work in order to provide the DON with a detailed photographic history of the TCRA at IR-02. Electronic versions of the photographs sorted by date and accompanied by a Project Photographic Log were developed and kept in the IR-02 electronic project file. A photographic log and a selection of photographs from all phases of the TCRA are presented in Appendix I.

6.0 WASTE CHARACTERIZATION, DISPOSAL, AND RECYCLING

This section describes the disposal method for each waste stream generated during the removal action. Several waste streams resulted from the removal activities, including contaminated soils and point sources, drums, bottles, jars and small containers, decontamination wastewater, used personal protective equipment (PPE), and metal debris. Over-packs and lab-packs were handled and disposed of by TtEC. A summary of the wastes generated is presented in Table 6-1.

Trucks hauling non-radioactive waste off site were inspected prior to loading. Additionally, all vendors were pre-qualified and the driver's license and medical card were checked to ensure they were current. A uniform hazardous waste or a non-hazardous waste manifest was filled out for each loaded truck and submitted to the DON for signature. Prior to shipment, original copies of the manifest were provided to the transporter for shipment. Copies of the waste profiles and waste manifests are included in Appendix F.

6.1 SOIL AND DEBRIS

Approximately 14,360 tons of contaminated soil and debris requiring off-site transportation and disposal were generated during the removal action at IR-02. These materials were either disposed of as LLRW, LLMW, or non-LLRW waste.

Materials that exceeded the screening criteria in Table 2-4 were handled as LLRW or LLMW. Approximately 11,840 tons of soil, 1,940 tons of metal debris, 420 tons of fire brick, 18 tons of concrete and plastic, 20 tons of hoses, and 20 tons of rocks were placed in roll-off bins and disposed of as LLRW. Additionally, approximately 100 tons of wire rope remain on site for disposal as LLRW. Prior to stockpiling, thee wire rope was hand scanned for radioactivity. Further, 2,033 devices and 261 buttons (discrete gamma-emitting devices [point sources]) and 3 pieces of radioactively contaminated MPPEH were removed during soil screening. Additionally, 48 pieces of small, unidentified radioactive debris were removed. These point sources were properly stored in Building 406 pending isotopic identification and disposal.

During the planning process for this TCRA, the review of historic data revealed a number of soil sample results indicative of substantial, gross chemical contamination. Specifically, PCBs (Aroclor 1260) were detected at 490,000 μg/kg and copper was detected at 198,000 milligrams per kilogram (TtEC, 2005). Although the majority of the excavated material was reused as backfill material following characterization sampling, an effort was made to segregate the material associated with the elevated concentrations. Additionally, soil and excavated material was under continuous visual inspection, wherein the field engineer and/or site superintendent identified and segregated visually stained and chemically contaminated material for off-site disposal. As a result of these efforts, approximately 1,100 cy of radiologically released soil was segregated and stockpiled for proper disposal. Samples results for the segregated material are summarized in Appendix F. Approximately 1,000 cy of wood debris and 100 cy of tires will be disposed of as non-LLRW.

To date, the soil and debris has not been profiled for waste determination and is currently being stored on site pending disposal. Upon designation and shipment, a waste manifest will be completed for each truckload transported off site and submitted to the DON for signature. Original copies of the manifests will be provided to the transporters and the disposal facilities.

6.2 DRUMS, BOTTLES, JARS, AND CONTAINERS WITH UNKNOWN CONTENT

At IR-02, 48 drums, 2 drums handled as LLRW, were recovered and over-packed. Additionally, 33 small containers and approximately 30 cylinders were recovered from the excavation. Many other drums were found during the excavation; however, the containers were empty and after screening they were treated as scrap metal. Drums were in various conditions upon discovery, ranging from crushed and deteriorated to rusted but structurally sound and holding contents. The drums contained diesel-contaminated soil, grease, PPE, plastic, metal pieces, and wood, and were discovered in varying degrees of decay. Because of the condition of the recovered drums, contents from the drums were placed into over-pack drums for proper handling and disposal. Some of the small containers and bottles contained liquids. Container and drum logs are included in Appendix F as Tables F-3 and F-4.

Drums and small containers unearthed during the excavation activities were first screened by field instruments for radioactivity and then sampled and analyzed for the presence of radioactive materials. Additional analyses such as ^{90}Sr and gamma spectroscopy were requested for several drums based upon review of the sample results.

For waste characterization, the over-pack drums and small containers underwent on-site hazardous categorization (HazCat) analysis for "waste compatibility screening," which is defined as a series of rapid, qualitative, and physical tests to determine potential hazards, handling precautions, storage criteria, and disposal classification of the materials in question. The over-pack drums consisted of non-hazardous, Resource Conservation and Recovery Act waste based on HazCat and radiological analyses. The over-pack drums were transported off site and disposed of at the Chemical Waste Management, Inc., Kettleman Hills Facility for subsequent transfer and disposal by incineration at Onyx Environmental Services, Port Arthur Treatment Facility in Port Arthur, Texas.

One over-pack drum was determined to be mixed waste based on HazCat and radiological analyses. Drum D-366 consisted of dark grey soil with rubber pieces (belts and gaskets) and exhibited ^{226}Ra activity at 3.07 picocuries per gram (pCi/g).

The Over-pack Drum Log and Lab-pack Drum Log (Appendix F) contains all the relevant information of each over-pack and lab-pack drum, including drum number, accumulation start date, disposal date, storage location, contents, waste designation, sample information, disposal facility, profile number, proper shipping names, EPA/Department of Toxic Substances codes, label information, and manifest type and number. Profiles and manifests are provided in Appendix F.

6.3 WASTEWATER STORAGE AND DISPOSAL

Wastewater generated from equipment decontamination activities and collected rainwater was collected and stored in a 6,500-gallon Baker tank. Additional rainwater was collected and stored in a 20,000-gallon Baker tank. A total of 34,000 gallons of wastewater was generated during the removal action. For waste characterization, one water sample per tank was collected and analyzed for VOCs, SVOCs, including PAHs, pesticides, PCBs, Title 22 metals, TPH-purgeable, and TPH-extractable, Hexavalent Chromium, herbicides, pH, oil/grease, cyanide, sulfides, flash point, phenols, chemical oxygen demand, total suspended solids, and total dissolved solids. Radiological analysis using on-site gamma spectroscopy was also performed on the samples, and none of the water samples taken indicated radioisotope activity greater than the water-release criteria stated in the Revised AM (TtEC, 2006). All wastewater was disposed of by using the on-site sanitary sewer under permit from the San Francisco Public Utilities Commission, Bureau of Environmental Regulation and Management. A separate permit was obtained for each disposal event.

6.4 USED PPE

All on-site activities were performed in modified Level D PPE. Chemically contaminated used PPE was consolidated with similar non-hazardous wastes in roll-off bins and transported off site and disposed of at the Chemical Waste Management, Inc., Kettleman Hills Facility for subsequent transfer and disposal by incineration at Onyx Environmental Services, Port Arthur Treatment Facility in Port Arthur, Texas. Profile and manifest documentation are provided in Appendix F.

6.5 MISCELLANEOUS TRASH AND SOLID WASTE

Approximately 30 compressed gas cylinders were recovered during excavation activities. The cylinders were determined to be inert, surveyed for radioactivity, and disposed of as trash.

7.0 RADIOLOGICAL DATA ASSESSMENT AND CONCLUSIONS

Before analysis of data can occur, it is necessary to perform a data quality assessment of the associated radiological data. The first step in this process is to review the original DQOs before moving on to the data quality assessment phase, as described in the SAP (TtEC, 2005). This section will expand further the entire process that took place for IR-02 radiological data.

After the radiological data assessment has taken place, it is then appropriate to examine the data to determine if it supports completion of the RAOs.

7.1 RADIOLOGICAL DATA QUALITY OBJECTIVES

DQOs are qualitative and quantitative statements developed to define the purpose of the data collection effort, clarify what the data should represent to satisfy this purpose, and specify the performance requirements for the quality of information to be obtained from the data. These outputs are used to develop a data collection design that meets all performance criteria and other design requirements and constraints. The EPA has developed a seven-step process to develop DQOs. During this process, it is important to note that the intent of the investigation is to define the extent of contamination and/or provide for a comprehensive risk assessment.

The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) recommends using the seven-step DQO process in the design of radiological surveys. This process tailors the survey to the particular conditions around each survey situation. This section summarizes the DQO elements applicable to the surveys that were performed under this plan.

7.1.1 State the Problem

The DON had determined upon review of previous site history and investigations that the site contained material and debris with radioactive anomalies that required a TCRA.

7.1.2 Identify the Decisions

Are radioactive materials identified during the initial radiological survey? Are radioactive materials identified during the radiological survey of each subsurface soil lift? Are the ROC results for the grid post-excavation sampling below the RROs listed in Table 2-4? Does the radiological survey of the excavation indicate areas with greater than 3 sigma over background? Are radioactive materials detected during the ex-situ screening of the excavated material within soil to be excavated?

After excavation was complete, 1) post-excavation sampling was performed using a grid system, and 2) a radiological survey was performed. Excavated soils were dewatered and scanned on screening pads for ex-situ screening to identify radioactively contaminated materials that may not have been detected during the surface survey.

7.1.3 Identify Inputs to the Decision

Previous chemical and radiological investigation results from the soil samples collected within the IR-02 boundaries are as follows;

- Results from the initial radiological survey, pre-excavation soil samples, radiological survey of each 30.5 cm (12-in) lift of soil
- Post-excavation sampling and the post-excavation radiological survey
- Ex-situ screening of excavated material

7.1.4 Define Study Boundaries

For a land area, the study boundary was the physical boundary of IR-02. For remedial action support surveys, the study boundary was the extent of the remedial action work area and associated support areas. Section 3.4 discussed the details of performing the pre-excavation radiological survey. Figures 4-1 and 4-2 of this completion report show the final excavation boundaries for IR-02. The Work Plan (TtEC, 2005) discussed the details of performing the radiological survey of each 30.5 cm (12-in) soil lift.

Post-excavation samples for PCBs, pesticides, Title 22 metals, and ROCs were collected within the bottom of the excavation and the sidewall slopes. Systematically located post-excavation radiological samples were collected at a minimum rate of 16 per systematic grid. The complete excavation footprint was radiologically surveyed as described in Section 4.12.

7.1.5 Develop a Decision Rule

The decision rule was, "If the survey results demonstrate compliance with the release criteria, then document the results in the project completion report. If the survey results do not demonstrate compliance with the release criteria, then additional assessment and/or remediation may be necessary."

The following were the decision rules used to evaluate the work that was performed:

1. If radioactive materials were identified during the field survey, the sources were removed.
2. If radioactive materials were identified during the survey of each 30.5 cm (12-in) lift, the sources were removed and the excavation of the lift proceeded. If radioactive materials were not identified, then excavation of the surveyed lift commenced.
3. Once the maximum limits of the excavation were reached, surveys and sampling were performed, the information documented, and the excavation was backfilled.
4. If radioactive materials were detected during ex-situ screening of the excavated material, it was handled as specified in the Work Plan (TtEC, 2005) and the material from that grid was placed into an appropriate waste container for disposal. If no radioactive materials were detected during secondary screening, the soil was

stockpiled for subsequent characterization and disposal. If radioactive contamination was found, then the materials were packaged and sent off site as LLRW.

7.1.6 Set Limits on Decision Errors

The pre-excavation characterization sampling plan was designed to generate sufficient data to better define the lateral extent of the material and debris.

The initial and subsequent radiological surveys were performed in accordance with the Work Plan (TtEC, 2005) and survey protocols were carefully followed to limit errors.

To limit decision errors, analytical method requirements and project-specific DQOs were established. Published analytical method and laboratory-specific performance requirements were the primary determiners of DQOs for precision and accuracy.

Third-party data validation was performed on all samples, except for waste characterization samples and on-site laboratory data. Eighty percent of the data was validated at EPA Level III and the remaining 20 percent was validated at Level IV. Sampling and analysis protocols were carefully followed to limit errors.

For radiological surveys, there are two types of decision errors that can be made. The first type of decision error, called a Type I error, occurs when the null hypothesis is rejected when it is actually true. A Type I error is sometimes called a "false positive." The probability of a Type I error is usually denoted by alpha (α). The Type I error rate is often referred to as the significance level or size of the test.

The second type of decision error, called a Type II error, occurs when the null hypothesis is not rejected when it is actually false. A Type II error is sometimes called a "false negative." The probability of a Type II error is usually denoted by beta (β). The *power* of a statistical test is defined as the probability of rejecting the null hypothesis when it is false. It is numerically equal to $1-\beta$, where β is the Type II error rate.

This survey was designed to limit Type I and Type II errors to 5 percent. It is important to minimize the chances of concluding that a survey unit meets the release limits (reject the null hypothesis) when it actually exceeds the limits (Type I Error), and concluding that a survey unit exceeds the release limit (accept the null hypothesis) when it actually meets the limit (Type II Error).

7.1.7 Optimize Data Collection

The details of the initial radiological survey were discussed in Section 3.3 of the Work Plan (TtEC, 2005). In addition, soil that exceeded greater than 3 sigma above the mean background was treated as a potential radiological waste and was analyzed by the on-site laboratory for confirmation.

The details of the radiological survey of each 30.5 cm (12-in) lift were discussed in Section 4.8. One random radiological post-excavation soil sample was collected on a 15 by 15 meters (50-foot by 50-foot) grid system along the bottom and one for every 15 meters (50 feet) linear of sidewall slope of the excavation. Systematic post-excavation soil/sediment samples were also collected after establishing a grid consisting of 2,000 m^2 cells (2,400 yd^2) over the IR-02 excavation site. Sixteen systematically located samples were collected from each grid cell (Figures 4-3 and 4-4). Random post-excavation soil samples were also analyzed for PCBs, pesticides, Title 22 metals, and ROCs. Systematic post-excavation soil samples were also analyzed for ROCs.

The entire exposed soil area was gamma scanned to assess potential radiological contamination. Two composite samples per 50-foot by 50-foot lift were collected from the conveyor system.

7.2 RADIOLOGICAL DATA QUALITY ASSESSMENT

This section details the field data assessment and the on-site laboratory assessment including data verification, data validation, data evaluation, and data quality assessment.

7.2.1 Field Data Assessment

The first level check for validating data integrity during collection and reporting was verification of numerical work. After collection of survey data each day, the results were reviewed by the RCT to verify their completeness. The purpose of the first level check was to ascertain that the data presented were free of numerical or transcription errors and that established procedures and methodology had been properly followed.

The RSO reviewed the data from the subcontractor to determine that it met the appropriate criteria including review of field logbooks, sample identifications, chains of custody, etc. No further action was required because all data were considered acceptable.

7.2.2 On-site Laboratory Data Assessment

Laboratory data were assessed to determine whether the objectives of the survey process were being met. The assessment process consists of four data phases: verification, validation, evaluation, and quality assessment. The assessment of HPS laboratory data ensures that the objective of the survey was met.

The laboratory sample data were tabulated and submitted in a format acceptable to the DON and regulatory agencies. The RSO reviewed the data from the contractor on-site laboratory to determine that data met SAP criteria (TtEC, 2005). No further action was required because all data were acceptable.

7.2.2.1 Data Verification

Data verification ensured that the requirements are implemented as prescribed. Data verification activities included inspections of the laboratory, documented QC checks performed on laboratory equipment in accordance with the appropriate SOP, technical reviews of data, and audits as appropriate.

7.2.2.2 Data Validation

As stated in the SAP in the Work Plan (TtEC, 2005), there were no standards for data validation of radiological analyses. Therefore, guidance documents and modified functional guidelines are used in validation of radiological data. Data not meeting method and/or SAP specifications were flagged as estimated or rejected.

7.2.2.3 Data Evaluation

On-site laboratory data are evaluated prior to submittal to the RASO. The evaluation of data was based on method requirements, results of QC checks, contamination in method blanks, and method spikes (as appropriate), and the overall indication of interference due to contamination. The data qualifiers, if used, were listed at the bottom of the data report. If the data was determined were acceptable for use, no qualifiers appear.

7.2.2.4 Data Quality Assessment

Data Quality Assessment (DQA) is a scientific and statistical evaluation that indicates if the data were of the right type, quality, and quantity to support their intended use. All data presented as a matter of function in this report were subject to the DQA process, and the data are determined suitable for use.

8.0 EFFECTIVENESS OF THE REMOVAL ACTION

The RAOs for this TCRA included removal of radiological contamination at IR-02. The AM (DON, 2001a) for HPS documented the decision to undertake a TCRA at areas with radiological contamination in soils, debris/slag, and buildings. The RAOs were as follows:

- Implement the Base-wide Radiological Removal Action Memorandum, and
- Protect public health and welfare and the environment by physically removing and disposing of radioactive contamination exceeding the RROs presented in the Work Plan.

The project Work Plan and appendices (TtEC, 2005a) detail the procedures and practices developed to achieve the objectives described above. The planned approach was a combination of excavation, extensive radiological screening and sampling, and site restoration. Although not presented as RAOs, secondary objectives for this TCRA included the collection of post-excavation and backfill material samples for select chemical analyses. Additionally, excavated soil that was visibly stained or grossly contaminated was segregated and not used as backfill material. This effort, combined with the use of clean import material to bridge the groundwater at the excavation bottom, was completed in an effort to reduce the availability of potential groundwater contaminant sources.

Given the positive assessment of data suitability detailed in Section 7.0, the indication of the status of the excavation sidewalls and bottom of the TCRA can be determined through a quantitative evaluation of the sampling results as they compare to the RROs (Table 2-4). All samples (38 sidewall, 63 random grid, and 160 systematic grid) were below the RROs for ^{137}Cs and ^{90}Sr (see Table 2-4). For the systematic grid samples, 155 of 160 samples obtained were below the RROs for ^{226}Ra (Table 2-4). For the random grid samples, 59 of 63 usable samples obtained were below the RROs for ^{226}Ra (see Table 2-4). The highest activity found in the post-excavation sampling was 6.225 pCi/g of ^{226}Ra in grid 127. In addition, 2,345 point sources and pieces of radioactively contaminated debris were removed during the excavations at IR-02 Northwest and Central Area. Further details of the effectiveness of sampling activities can be found in Section 9.0.

The RAOs stated above were achieved for IR-02. A Any remaining radiological materials below the excavation boundary or beyond the sidewalls of the excavation site are now under a cap of clean soil (Section 5.1), with the exception of the elevated readings in grids 40, 90, and 175 discussed in Section 5.3.. Excavated material used as backfill was characterized as detailed in the Work Plan, with stained material being segregated and identified for disposal. Post-excavation samples were collected to be used in the Parcel E and E-2 FS. The site was backfilled and the final stages of restoration are underway.

9.0 QUALITY CONTROL AND QUALITY ASSURANCE

This section discusses QA/QC objectives for the IR-02 post-excavation and import material samples. Chemical analysis was performed by Curtis and Tompkins, Ltd. (C&T), and off-site radiological analysis was performed by Eberline Services (Eberline). C&T and Eberline are state of California-certified and DON-evaluated laboratories. Subsequently, a third-party validation company (Laboratory Data Consultants, Inc.) performed data validation on the C&T analyses. The validation was conducted in accordance with *Environmental Work Instruction (EWI) #1, 3EN2.1, Chemical Data Validation* (DON, 2001b); the Contract Laboratory Program *National Functional Guidelines For Organic Data Review, EPA 54D/R-99/008* (EPA, 1999); the Contract Laboratory Program *National Functional Guidelines for Inorganic Data Review, EPA 54D/R-04/004* (EPA, 2004); the *Quality Systems Manual for Environmental Laboratories* (Department of Defense [DoD], et al., 2000b), and the criteria specified in the Work Plan (TtEC, 2005). Twenty percent of the samples were validated in accordance with an EPA Level IV-equivalent protocol. The remaining 80 percent of the samples were validated with an EPA Level III-equivalent protocol.

The chain-of-custody records and data validation reports (which include laboratory analytical results) are included in Appendix L. The analytical results from the sampling activities are presented in Appendices D and E for the post-excavation and import material samples, respectively.

The following sections describe the fulfillment of the field QC sampling objectives and analytical QC objectives for this project. Tables 9-1 through 9-5 summarize the samples and the associated analytical quality control objective for each method that were qualified by the validator as a result of the QC criteria outside of control limits.

9.1 FIELD QUALITY CONTROL SAMPLING OBJECTIVES

Field QC sampling objectives were met per the SAP (Appendix A in the Work Plan [TtEC, 2005]) including the collection of 2 field duplicates and 9 matrix spike and matrix spike duplicates (MS/MSDs). The results of the field QC sampling are described in the following sections.

9.1.1 Field Duplicates

Field duplicates consist of two samples (an original and a duplicate) of the same matrix collected at the same time and location, to the extent possible, using the same sampling technique. The purpose of the field duplicate is to evaluate the precision of the overall sample collection and analysis process through the calculation of the relative percent difference (RPD) for duplicate pairs. Field duplicates are routinely collected at a frequency of 1 per every 10 samples and analyzed for the same parameters as the original sample. The RPD QC limit was established at 25 percent, and 1 out of 2 field duplicate pairs did not meet this criterion due to various project-specific factors, including non-homogenous matrix, high percent sample moisture, and sample analysis dilutions. Data are not independently qualified based on field duplicates RPD values; therefore, no results were qualified as a result of field duplicate RPDs outside of QC limits.

9.1.2 Matrix Spike and Matrix Spike Duplicate

MS/MSD samples are prepared for chemical analysis by spiking the sample with a known amount of a target analyte. Once the spike is added to the MS/MSD sample, the sample is carried through the complete sample preparation process along with the other samples in the batch. The percent recoveries (%R) for the MS/MSD samples are compared against each other and against the known amount of the spike to measure the accuracy of the analytical method. RPD values from the MS/MSD samples are calculated to evaluate the analytical precision of the method. One MS/MSD sample is routinely collected for every 20 samples. The %R and RPDs were within the specified QC limits described in the SAP contained in the Work Plan (TtEC, 2005), except for those listed in Table 9-3. These samples were flagged "J/UJ" (estimated value or estimated at less than the laboratory reporting limit) for the associated analyses. For radiological analyses, a laboratory duplicate is prepared instead of an MS/MSD. The duplicate error ratio was within QC limits for all samples.

9.2 ANALYTICAL DATA QUALITY OBJECTIVES

The following sections describe the fulfillment of the analytical data quality objectives in terms of precision, accuracy, representativeness, completeness, and comparability parameters, as described in the SAP contained in the Work Plan (TtEC, 2005).

9.2.1 Precision and Accuracy

In accordance with the analytical methods, the *Quality Systems Manual for Environmental Laboratories* (DoD, et al., 2000a), and the SAP (Appendix A in the Work Plan [TtEC, 2005]) specifications, the following parameters were assessed by the third-party validation company as applicable to chemical analyses:

- Technical holding times
- Instrument performance checks
- Initial and continuing calibration verifications
- Method blanks
- Surrogate %R
- Laboratory control samples
- Minimum detectable activity

- Internal standards
- Inductively coupled plasma (ICP) Serial Dilution
- Target compound identification
- Compound quantitation
- System performance

9.2.1.1 Technical Holding Times and Preservation

Sample holding times and preservation were checked against QC criteria, and all samples met criteria.

9.2.1.2 Instrument Performance Checks

Instrument performance checks were completed, and all QC requirements were met.

9.2.1.3 Initial and Continuing Calibration Verifications

Initial and continuing calibrations were performed. Percent relative standard deviations of initial calibration and percent differences of continuing calibration did not meet the QC requirement for all samples as illustrated in Tables 9-2, 9-3, and 9-4. Associated samples were flagged "J/UJ" for affected compounds.

9.2.1.4 Method Blanks

Sample concentrations were compared to concentrations detected in the method blanks. For sample concentrations either not detected or less than 5 times blank contaminant concentrations, associated results were flagged "U" (not detected). For sample concentrations detected but greater than 5 times blank contaminant concentrations, sample results were not affected. Tables 9-2, 9-3, 9-4, and 9-5 list the affected samples.

9.2.1.5 Surrogate Percent Recovery

Surrogate recovery applies to organic analyses. All surrogate percent recoveries were within QC limits, except for the samples listed in Table 9-1. These samples were flagged "J" for all detected compounds for associated analyses.

9.2.1.6 Laboratory Control Samples

All laboratory control samples were within QC limits.

9.2.1.7 Internal Standards

All internal standard areas and retention times were within QC limits except for samples listed in Table 9-4. Associated sample results were flagged "J/UJ".

9.2.1.8 ICP Serial Dilution

ICP serial dilutions (applicable to metals analysis only) were within QC limits except for the samples listed in Table 9-3. Associated samples and analytes were flagged "J".

9.2.1.9 Target Compound Identification

All target analytes were correctly identified.

9.2.1.10 Compound Quantitation

Compound quantitation (applicable to pesticide analysis only) were within QC limits except for the samples listed in Table 9-2. Associated samples and analytes were flagged "J".

9.2.1.11 System Performance

System performance met all QC requirements. No discrepancies were reported.

9.2.2 Representativeness

Representative data were obtained through selection of sampling locations and analytical parameters to meet the DQOs of this project. Proper collection and handling of samples, and the use of established field and laboratory procedures as described in the SAP contained in the Work Plan (TtEC, 2005) were followed.

9.2.3 Completeness

The percent completeness is defined as the percentage of measurements judged to be valid. The completeness goal is to generate a sufficient amount of valid data to meet project objectives. Completeness is calculated and reported for each method, matrix, and analyte combination. The number of valid results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set. For completeness requirements, valid results are all results not qualified with an "R" flag for rejected. The requirement for completeness is 90 percent for soil samples. The percent completeness for soil and water samples is 100 percent for this project.

9.2.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Sample data should be comparable with other measurements for similar samples and sample conditions. The objective for the QA/QC program is to produce data with the greatest possible degree of comparability. The number of matrices sampled and the range of field conditions encountered are considered in determining comparability. Comparability is achieved by using standard methods for sampling and analysis, reporting data in standard units, normalizing results to standard conditions, and using standard and comprehensive reporting formats.

9.3 OVERALL ASSESSMENT OF DATA

Overall, the data are valid and usable and have been qualified for analytical parameters that did not meet criteria as described in Section 9.2.

9.4 COMPARISON OF ON-SITE AND OFF-SITE RADIOLOGICAL DATA

This evaluation focused on both the effectiveness and the quality of the radiological sample analysis. For purposes of this evaluation effectiveness is defined as the adequacy of the sample analysis method to detect ROCs at levels equal to or less than the applicable derived concentration guideline level (DCGL), while quality is defined as high degree of correlation between samples analyzed both on site and off site.

9.4.1 Effectiveness of Radiological Sampling

Tables 4-4 through 4-6 identify the activity, uncertainty, and corresponding MDA for each sample analyzed by both on-site and off-site laboratories. Individual post-excavation sample results can be found in Appendix G. The ROCs for these analyses were ^{137}Cs and ^{226}Ra. MDAs for the on-site lab showed a strong trending value and the MDA for a particular ROC on any given sample was generally consistent across all samples. Off-site lab MDAs were in general comparable to on-site lab MDAs, but have less uncertainty and again showed good trending.

Levels of ^{226}Ra exceeded the Radiological Remedial Objective (RRO) in onsite analysis of post-excavation samples at the following grids:

- Grid 93 systematic grid (2.321 pCi/g) – Survey Unit 4, location E4
- Grid 124 systematic grid (3.015 pCi/g) – Survey Unit 6, location D2
- Grid 127 random grid (3.783 pCi/g) – Survey Unit 5, location R127PE
- Grid 130 random grid (6.225 pCi/g) – Survey Unit 2, location R130PE
- Grid 135 systematic grid (2.189 pCi/g) – Survey Unit 6, location B1
- Grid 150 random grid (2.059 pCi/g) – Survey Unit 9, location R150PE
- Grid 152 systematic grid (2.380 pCi/g) – Survey Unit 8, location C3
- Grid 164 random grid (2.237 pCi/g) – Survey Unit 8, location R164PE
- Grid 165 systematic grid (2.213 pCi/g) – Survey Unit 9, location C1

No off-site sample was available for comparison. However, several neighboring samples from within the same grid were available for comparison and none of them showed elevated radium levels.

As mentioned in Section 4.12, several other samples near the RRO were evaluated against neighboring samples from the same grid or against complementary laboratory sampling. In no case were there multiple confirmations of elevated readings in any grid sampled.

9.4.2 Quality of Radiological Sampling

The requirements in the Work Plan SAP (TtEC, 2005) specified that 10 percent of all radiological samples would be sent off site for analysis and compared to on-site results. In achieving this goal, a comprehensive evaluation of the quality of all post-excavation radiological samples was performed. In comparing samples where both on-site and off-site analyses were performed, in all cases the results are complementary to each other. The on-site and off-site sample data can be found in Tables 4-4 through 4-6.

9.4.3 Overall Assessment of Radiological Sampling Data

Analysis of the radiological sampling data has shown that the sample analysis had good quality and effectiveness. It is therefore concluded that the combination of on-site and off-site sampling clearly demonstrates that no widespread residual radioactive contaminants above the DCGLs were present at the sampled locations.

10.0 COMMUNITY RELATIONS ACTIVITY

Several community relations activities were conducted to inform the public of MDR/MSA TCRA activities. The remediation process was conducted in accordance with the *Final Radiological Risk Communication Plan* (Foster Wheeler Environmental, Inc [FWENC], 2003); the *Final Community Involvement Plan* (Innovative Technical Solutions, Inc and Tetra Tech, Inc., 2004); and the *Final Community Outreach Plan* (TtFW, 2004b). These documents were prepared for HPS to facilitate public involvement in the decision-making process and to keep the public informed of ongoing remedial activities.

10.1 PUBLIC INFORMATION

The Work Plan (TtEC, 2005), this Removal Action Completion Report, and other documentation associated with remediation activities at HPS are contained in the Administrative Record for the site. The Administrative Record Index is maintained by NAVFAC SW and is available to the public at the NAVFAC SW offices at 1220 Pacific Highway, San Diego, California, 92132-5190.

The DON, as lead agency with state agency concurrence, has overall responsibility for public participation activities. As such, the Work Plan (TtEC, 2005), this RACR, and other documentation associated with remediation activities at HPS is available to the public at the information repositories. There are two public information repositories where the public can review any of the documents associated with the Administrative Record. The repositories are:

San Francisco Main Library
100 Larkin Street
Government Information Center, 5th Floor
San Francisco, CA 94102
(415) 557-4500

Anna E. Waden Library
5075 Third Street
San Francisco, CA 94124
(415) 715-4100

10.2 PUBLIC PARTICIPATION

To encourage local participation in the hazardous waste cleanup program at HPS, the DON established a Restoration Advisory Board (RAB). This board is a citizen-based committee representing local community interests. RAB meeting agendas, minutes, and presentation materials are included in the Administrative Record for public review.

The RAB held meetings during the investigation and field work. All meetings were advertised locally in an effort to encourage public attendance and participation. In addition, the DON prepared a master mailing list of the local community members, and whenever significant cleanup activities or decisions were planned, the community members were notified by mail for information purposes and involvement.

The original version of the AM (DON, 2001a) was issued to the RAB for review. A public notice was posted in the local newspaper, inviting public comments. The purpose of the public notice was to invite the interested community members to review the subject AM (DON, 2001a) and provide their comments or questions. During 2006, the AM (DON, 2001a) was revised as more stringent and additional release criteria were established (TtEC, 2006). Copies of the revised document were placed for review in the HPS information repositories. The most notable change in the AM revision was that the ^{137}Cs DCGL was revised downward approximately 13 percent, in keeping with the EPA PRG for this radioisotope. Once the AM revision was published as final, the more restrictive release criteria for ^{137}Cs were put into place for the remaining work performed under the TCRA.

To keep the public informed of ongoing activities at HPS the Navy periodically publishes fact sheets and distributes them to the public. During this project there were two fact sheets (Numbers 4 and 7) prepared that covered IR-02 (Appendix K). Fact Sheet Number 4 was issued in October 2003 and announced plans to clean up IR-02. Fact Sheet Number 7 was issued in June 2005 and detailed the initiation of the TCRA at IR-02, as well other activities in Parcels E and E-2. Fact Sheet Number 7 was mailed to 2,631 local community members on the HPS mailing list on June 15, 2005.

11.0 RECOMMENDATIONS

The RAOs for all materials excavated were achieved, with the exception of nine post-excavation sample results slightly exceeding the RROs, as described in Sections 8.0 and 9.4.1. Within the boundaries of the excavation site, remaining radiological materials above or below the RROs, or otherwise not removed, are under a cap of clean import soil, thereby mitigating certain pathways of exposure to radioactive contaminants for surrounding populations and ecosystems from areas that were addressed as part of this excavation. Extensive chemical characterization of excavated and in situ material was performed to aid in refining the current understanding of chemical contamination and the nature of the fill material at and adjacent to IR-02. Qualitative practices were implemented to identify, segregate, and dispose of visually stained or contaminated soil from the excavation.

Based on the findings of this TCRA, and experience garnered during implementation, recommendations for actions at or adjacent to IR-02 include the following:

- Evaluate all data (both chemical and radiological) collected during and subsequent to removal action activities with respect to the contaminant distribution as presented in the Parcels E and F conceptual site models. This evaluation should include an assessment of remedial options for IR-02 and Areas 8, 9, and 10 in Parcel F.
- Continue regular groundwater monitoring to identify and assess the impact of the removal action activities described in this RACR.
- Complete the disposal of all project-generated soil not used as backfill material.
- Evaluate and implement options for disposition of metal debris, cable, and wood material currently staged and secured as low-level radioactive waste in Parcel E, as appropriate.

12.0 REFERENCES

Atomic Energy Commission (AEC). 1974. *Regulatory Guide 1.86.*

California Department of Water Resources. 1991. *California Well Standards. Bulletin 74-90, Supplement to Bulletin 74-81.*

Department of Defense (DoD), Department of Energy, Nuclear Regulatory Commission (NRC), and U.S. Environmental Protection Agency (EPA). 2000a. *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM). NUREG-1575. August.

________________. 2000b. *Quality Systems Manual for Environmental Laboratories.* October.

Department of the Navy (DON), Southwest Division Naval Facilities Engineering Command. 2001a. *Final Basewide Radiological Removal Action, Action Memorandum for Hunters Point Shipyard.* November 19.

________________. 2001b. *Environmental Work Instruction (EWI) #1, 3EN2.1, Chemical Data Validation.*

Foster Wheeler Environmental Corporation, Inc. (FWENC). 2003. *Final Radiological Risk Communication Plan for Hunters Point Shipyard, San Francisco, California.* November 26.

Innovative Technical Solutions, Inc. and Tetra Tech, Inc. (TtEC). 2004. *Final Community Involvement Plan, Hunters Point Shipyard, San Francisco, California.* April 21.

Naval Sea Systems Command (NAVSEA). 2004. *Final Historical Radiological Assessment, Volume II.* History of the Use of General Radioactive Materials 1939–2003. August 31.

__________________. 2005. *OP-5, Ammunition and Explosives Ashore Safety Regulations for Handling, Storage, Production, Renovation, & Shipping, Volume 1.*

PRC Environmental Management, Inc. (PRC). 1996. *Draft Final Report, Results of Subsurface Radiation Investigation in Parcels B and E, Hunters Point Shipyard, San Francisco, California.* July 12.

San Francisco Redevelopment Agency (SFRA). 1997. Reuse Plan.

Tetra Tech EC, Inc. (TtEC). 2005. *Final Project Work Plan, Time-Critical Removal Action for IR-02, Parcel E, Hunters Point Shipyard, San Francisco CA.* November 10.

__________________. 2006. *Final Basewide Radiological Removal Action, Action Memorandum - Revision 2006.* April 21.

Tetra Tech EMI, Inc. (TtEMI), Uribe and Associates (U&A), and Levine-Fricke-Recon, Inc. 1997. *Draft Final Parcel E Remedial Investigation Report, Hunters Point Shipyard, San Francisco, California.* October 27.

__________________ 1998. *Draft Parcel E Feasibility Study, Hunters Point Shipyard, San Francisco, California.* January.

Tetra Tech FW, Inc (TtFW). 2004a. *Final Biological Assessment.* Parcel E, Hunters Point Shipyard, San Francisco, California. April 26.

__________________. 2004b. *Final Community Outreach Plan for Hunters Point Shipyard, San Francisco California.* June 7.

__________________. 2005a. *Base-wide Radiological Work Plan.* Hunters Point Shipyard, San Francisco, California.

__________________. 2005b. *HPS Standard Operating Procedure* (SOP)-HPO-Tt-006, Radiation and Contamination Surveys.

U.S. Environmental Protection Agency (EPA). 1999. *Contract Laboratory Program National Functional Guidelines for Organic Data Review, EPA 54D/R-99/008.*

__________________. 2004. *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, EPA 54D/R-04/004.*

TABLES

TABLE 2-1

METALS DETECTED IN PREVIOUS INVESTIGATIONS AT IR-02

Analyte	Number of Detections/ Analyses	Maximum Detected Concentration (mg/kg)	PRG Value (mg/kg)	Number of Samples Exceeding PRG	HPAL[a] Value (mg/kg)	Number of Samples Exceeding HPAL
Antimony	51/77	1,930	30.7	25	9.05	43
Arsenic	76/82	53	0.32	76	11.10	24
Barium	81/82	16,200	5,340	1	314.36	16
Beryllium	42/82	4.3	0.14	38	0.71	20
Cadmium	47/82	102	9.0	11	3.14	26
Chromium	82/82	1,140	211	31	a	25
Hexavalent chromium	8/134	1.1	0.20	5	NA	N/A
Cobalt	81/82	1,380	NA	N/A	a	5
Copper	82/82	198,000	2,850	13	124.31	54
Lead	82/82	19,700	130	52	8.99	79
Manganese	82/82	2,810	382	67	1,431.18	10
Mercury	62/81	69.2	23.0	2	2.28	19
Molybdenum	57/81	137	383	0	2.68	33
Nickel	82/82	10,300	150	40	a	19
Selenium	12/73	4.1	383	0	1.95	1
Silver	48/79	82	383	0	1.43	35
Vanadium	80/82	488	537	0	117.17	10
Zinc	82/82	25,000	23,000	1	109.86	62

Notes:

a HPALs for chromium, cobalt, and nickel are based on magnesium concentration in a given sample; thus, no single value applies to all samples

Abbreviations and Acronyms:

HPAL – Hunters Point ambient level
IR – Installation Restoration
mg/kg – milligrams per kilogram
N/A – not applicable
NA – not available
PRG – preliminary remediation goal
TtEMI – Tetra Tech EM, Inc.

Source:

TtEMI et al., 1997

TABLE 2-2

PCBs DETECTED IN PREVIOUS INVESTIGATIONS AT IR-02

Analyte	Number of Detections/Analyses	Maximum Detected Concentration (μg/kg)	PRG Value (μg/kg)	Number of Samples Exceeding PRG
Aldrin	1/86	650	26	1
Aroclor 1254	6/86	2,200	1,400	1
Aroclor 1260	37/86	490,000	66	36

Abbreviations and Acronyms:

μg/kg – micrograms per kilogram
PCB – polychlorinated biphenyl
PRG – Preliminary Remediation Goal
TtEMI – Tetra Tech EM, Inc.

Source:

TtEMI et al., 1997

TABLE 2-3

TPH DETECTED IN PREVIOUS INVESTIGATIONS AT IR-02

Analyte	Number of Detections/ Analyses	Maximum Detected Concentration (mg/kg)	Screening Criterion (mg/kg)	Number of Samples Exceeding Screening Criterion
TPH-g	26/80	6,400	100	5
TPH-d	33/80	14,000	1,000	4
TOG	73/80	53,000	1,000	29
TPH-purgeable	4/14	9,500	100	4
TPH-extractable	16/32	28,000	1,000	2

Abbreviations and Acronyms:

IR – Installation Restoration
mg/kg – milligrams per kilogram
TOG – total oil and grease
TPH – total petroleum hydrocarbons
TPH-d – total petroleum hydrocarbons quantified as diesel
TPH-g – total petroleum hydrocarbons quantified as gasoline
TPH-extractable – total extractable petroleum hydrocarbons
TPH-purgeable – total purgeable petroleum hydrocarbons
TtEMI – Tetra Tech EM, Inc.

Source:

TtEMI et al., 1997

TABLE 2-4

RADIOLOGICAL REMEDIAL OBJECTIVES AND RELEASE CRITERIA

Radionuclide	Half-life	Radiations	Surfaces		Soil[a] (pCi/g)		Liquid[f] (pCi/L)
			Equipment, Waste ($dpm/100\ cm^2$)[b]	Residual Dose (mrem/yr)[c]	Outdoor Worker (pCi/g)[d]	Residual Dose (mrem/yr)[c]	
Cesium-137	30 years	Beta/gamma (β-,γ)	5,000	1.72	0.113	0.2142	119
Radium-226	1,600 years	Alpha (α)/gamma (γ)	100	0.612	1.0[e]	6.342	5[g]
Strontium-90	28.6 years	Beta (β-)	1,000	0.685	10.8	0.1931	8

Notes:

a EPA PRGs for two future-use scenarios.
b These limits are based on AEC *Regulatory Guide 1.86* (1974). Limits for removable surface activity are 20 percent of these values.
c The resulting dose is based on modeling using RESRAD-Build Version 3.3 or RESRAD Version 6.3, with radon pathways turned off.
d The on-site and off-site laboratory will ensure that the MDA meets the listed release criteria by increasing sample size or counting time as necessary. The MDA is defined as the lowest net response level, in counts, that can be seen with a fixed level of certainty, customarily 95 percent. The MDA is calculated per sample by considering background counts, amount of sample used, and counting time.
e Limit is 1 pCi/g above background, per agreement with EPA.
f Release criteria for liquids have been derived from *Radionuclides Notice of Data Availability Technical Document* (EPA, 2000) by comparing the limits from two criteria and using the most conservative limit.
g Limit is for total radium concentration.

Abbreviations and Acronyms:

AEC – Atomic Energy Commission
cm^2 – square centimeters
dpm – disintegrations per minute
EPA – U.S. Environmental Protection Agency
MDA – minimum detectable activity
mrem/yr – millirem per year
pCi/g – picocurie per gram
pCi/L – picocurie per liter
PRG – preliminary remediation goal
Types of radiation: α - alpha, β - beta, γ - gamma

TABLE 4-1

UXO SCREENING LOG

Date	Item Number	Item Size / Description	MPPEH Type	Category
07/05/05	UXO-0008	5.56 MM Ball	MD	5X
07/06/05	UXO-0009	5 IN Protective Cap	MD	5X
07/13/05	UXO-0013	40 MM Casing	MD	5X
07/13/05	UXO-0014	5 IN Casing	MD	5X
07/18/05	UXO-0019	5 IN Casing	MD	5X
07/18/05	UXO-0021	5 IN Casing	MD	5X
07/20/05	UXO-0023	5 IN Casing	MD	5X
07/20/05	UXO-0025	5 IN Protective Cap	MD	5X
07/26/05	UXO-0034	40 MM Casing	MD	5X
07/27/05	UXO-0035	5 IN Casing	MD	5X
07/28/05	UXO-0039	5.56 MM Casing	MD	5X
07/28/05	UXO-0040	40 MM Casing	MD	5X
07/28/05	UXO-0041	.38 Cal Casing	MD	5X
07/29/05	UXO-0042	40 MM Casing	MD	5X
07/30/05	UXO-0043	40 MM Casing	MD	5X
07/30/05	UXO-0044	5 IN Casing	MD	5X
07/30/05	UXO-0045	5 IN Casing	MD	5X
07/30/05	UXO-0046	5 IN Casing	MD	3X
08/01/05	UXO-0047	40 MM Casing	MD	5X
08/01/05	UXO-0048	5 IN Casing	MD	3X
08/01/05	UXO-0051	40 MM Casing	MD	5X
08/01/05	UXO-0052	40 MM Casing	MD	5X
08/04/05	UXO-0057	5.56 MM Casing	MD	5X
08/05/05	UXO-0059	5 IN Casing	MD	5X
08/05/05	UXO-0060	40 MM Casing	MD	5X
08/05/05	UXO-0061	5 IN Casing	MD	5X
08/05/05	UXO-0062	40 MM Casing	MD	3X
08/05/05	UXO-0063	5 IN Casing	MD	5X
08/05/05	UXO-0064	5 IN Casing	MD	5X
08/05/05	UXO-0065	40 MM Casing	MD	3X
08/05/05	UXO-0066	40 MM Casing	MD	5X
08/09/05	UXO-0067	5 IN Casing	MD	3X
08/09/05	UXO-0068	5 IN Casing	MD	3X
08/09/05	UXO-0069	3 IN Casing	MD	5X
08/09/05	UXO-0070	5 IN Casing	MD	5X
08/10/05	UXO-0071	40 MM Casing	MD	5X
08/10/05	UXO-0072	40 MM Casing	MD	5X
08/10/05	UXO-0073	40 MM Casing	MD	5X

TABLE 4-1

UXO SCREENING LOG

Date	Item Number	Item Size / Description	MPPEH Type	Category
08/10/05	UXO-0074	7.62 MM Casing	MD	5X
08/10/05	UXO-0075	20 MM Casing	MD	5X
08/11/05	UXO-0076	3 IN Casing	MD	5X
08/11/05	UXO-0077	5 IN Casing	MD	3X
08/11/05	UXO-0078	7.62 MM Casing	MD	3X
08/11/05	UXO-0079	5 IN Casing	MD	5X
08/11/05	UXO-0080	4 IN Casing	MD	5X
08/16/05	UXO-0081	5 IN Casing	MD	5X
08/16/05	UXO-0082	40 MM Casing	MD	5X
08/16/05	UXO-0083	20 MM Casing	MD	5X
08/17/05	UXO-0084	.50 CAL Casing	MD	5X
08/17/05	UXO-0085	20 MM Casing	MD	5X
08/18/05	UXO-0086	3 IN Casing	MD	5X
08/18/05	UXO-0087	40 MM Casing	MD	3X
08/22/05	UXO-0088	5 IN Casing	MD	5X
08/22/05	UXO-0089	5 IN Casing	MD	5X
08/23/05	UXO-0090	5 IN Projectile	MD	3X
08/23/05	UXO-0091	8 IN Casing	MD	3X
08/24/05	UXO-0092	5 IN Casing	MD	3X
08/25/05	UXO-0095	5 IN Casing	MD	5X
08/25/05	UXO-0096	5 IN Casing	MD	5X
08/25/05	UXO-0097	40 MM Casing	MD	5X
08/26/05	UXO-0098	3 IN Casing	MD	5X
08/29/05	UXO-0099	5 IN Casing	MD	5X
08/29/05	UXO-0100	4 IN Casing	MD	3X
08/29/05	UXO-0101	40 MM Casing	MD	3X
08/29/05	UXO-0102	40 MM Casing	MD	3X
08/30/05	UXO-0103	40 MM Casing	MD	3X
08/30/05	UXO-0104	40 MM Casing	MD	5X
08/30/05	UXO-0105	3 IN Casing	MD	5X
08/31/05	UXO-0106	3 IN Casing	MD	5X
08/31/05	UXO-0107	40 MM Casing	MD	5X
08/31/05	UXO-0108	3 IN Casing	MD	5X
08/31/05	UXO-0109	40 MM Casing	MD	3X
09/08/05	UXO-0110	40 MM Casing	MEC	1X
09/08/05	UXO-0111	40 MM Casing	MD	3X
09/08/05	UXO-0112	5 IN Casing	MD	5X
09/09/05	UXO-0113	40 MM Casing	MD	3X

TABLE 4-1

UXO SCREENING LOG

Date	Item Number	Item Size / Description	MPPEH Type	Category
09/09/05	UXO-0114	5 IN Casing	MD	5X
09/09/05	UXO-0115	40 MM Casing	MD	5X
09/09/05	UXO-0116	3 IN Casing	MD	5X
09/12/05	UXO-0119	3 IN Casing	MD	5X
09/12/05	UXO-0120	40 MM Casing	MD	3X
09/12/05	UXO-0121	40 MM Casing	MD	5X
09/12/05	UXO-0123	3 IN Casing	MD	5X
09/12/05	UXO-0124	5 IN Casing	MD	5X
09/13/05	UXO-0125	5 IN Casing	MD	5X
09/13/05	UXO-0126	5 IN Casing	MD	5X
09/13/05	UXO-0129	40 MM Casing	MD	5X
09/13/05	UXO-0130	40 MM Casing	MD	3X
09/13/05	UXO-0134	40 MM Casing	MD	3X
09/13/05	UXO-0135	3 IN Casing	MD	5X
09/13/05	UXO-0136	5 IN Protective Cap	MD	5X
09/13/05	UXO-0138	5 IN Casing	MD	5X
09/15/05	UXO-0140	5 IN Casing	MD	3X
09/15/05	UXO-0141	5 IN Casing	MD	5X
09/16/05	UXO-0142	3 IN Casing	MD	3X
09/16/05	UXO-0143	40 MM Casing	MD	5X
09/16/05	UXO-0144	5 IN Casing	MD	3X
09/18/05	UXO-0146	40 MM Casing	MD	3X
09/19/05	UXO-0147	4 IN Casing	MD	5X
09/19/05	UXO-0148	5 IN Protective Cap	MD	5X
09/19/05	UXO-0149	5 IN Protective Cap	MD	5X
09/19/05	UXO-0150	4 IN Casing	MD	5X
09/19/05	UXO-0151	4 IN Casing	MD	5X
09/19/05	UXO-0152	3 IN Casing	MD	3X
09/19/05	UXO-0153	5 IN Casing	MD	5X
09/28/05	UXO-0154	4 IN Casing	MD	5X
09/28/05	UXO-0155	3 IN Casing	MD	5X
09/28/05	UXO-0156	3 IN Casing	MD	5X
09/28/05	UXO-0157	3 IN Casing	MD	5X
09/29/05	UXO-0162	3 IN Casing	MD	3X
09/29/05	UXO-0163	3 IN Casing	MD	5X
09/30/05	UXO-0164	5 IN Casing	MD	5X
09/30/05	UXO-0167	5 IN Casing	MD	5X
09/30/05	UXO-0168	40 MM Casing	MD	5X

TABLE 4-1

UXO SCREENING LOG

Date	Item Number	Item Size / Description	MPPEH Type	Category
10/03/05	UXO-0171	.50 CAL Casing	MD	5X
10/03/05	UXO-0172	20 MM Casing	MD	3X
10/04/05	UXO-0174	5 IN Casing	MD	5X
10/04/05	UXO-0175	5 IN Casing	MD	5X
10/05/05	UXO-0177	40 MM Casing	MD	3X
10/05/05	UXO-0178	40 MM Casing	MD	5X
10/05/05	UXO-0179	40 MM Casing	MD	5X
10/05/05	UXO-0180	5 IN Casing	MD	5X
10/06/05	UXO-0181	5 IN Casing	MD	3X
10/07/05	UXO-0185	5 IN Casing	MD	5X
10/07/05	UXO-0187	5 IN Casing	MD	5X
10/07/05	UXO-0188	40 MM Casing	MD	5X
10/10/05	UXO-0189	5 IN Casing	MD	3X
10/10/05	UXO-0192	3 IN Casing	MD	5X
10/10/05	UXO-0193	5 IN Casing	MD	5X
10/12/05	UXO-0196	5 IN Casing	MD	5X
10/12/05	UXO-0197	5 IN Casing	MD	5X
10/13/05	UXO-0198	40 MM Casing	MD	3X
10/13/05	UXO-0199	5 IN Casing	MD	5X
10/13/05	UXO-0200	5 IN Casing	MD	5X

Abbreviations and Acronyms:

IN – inch
MD – munitions debris
MEC – munitions and explosives of concern
MM – millimeter
MPPEH – material potentially presenting an explosive hazard
UXO – unexploded ordnance

TABLE 4-2

DERIVED AIRBORNE CONCENTRATIONS

Radionuclide	Worker	
	DAC (µCi/mL)	10% DAC (µCi/mL)
Radium-226	3.0E-10	3.0E-11
Strontium-90	8.0E-9	8.0E-10
Cesium-137	6.0E-8	6.0E-9

Notes:

The above guideline values were determined using the NRC's 10 CFR, Part 20, Appendix B.

Abbreviations and Acronyms:

µCi/mL – microcurie per milliliter (concentration)
CFR – Code of Federal Regulations
DAC – derived air concentration
NRC – Nuclear Regulatory Commission

TABLE 4-3

INSTRUMENTATION FOR RADIOLOGICAL SURVEYS

Measurement/ Technique	Type of Instrumentation		Typical Background	Typical Efficiency (%)	Detection Sensitivity
	Detector	Meter			
Surface alpha/beta scans	Large-area gas proportional 43-68 (126 cm^2)	Data logger, 2350-1, 2360	150-250 cpm β 0-2 cpm α	~6 β total Efficiency ~6 α total efficiency	~ 900 dpm/100 cm^2 β ~ 100 dpm/100 cm^2 α
Direct measurement static alpha/beta	Scintillation, Ludlum Model 43-89 (100 cm^2)		100-200 cpm β 0-2 cpm α		
Stationary conveyor / surface scans	NaI scintillation Ludlum Model 44-10	Ludlum Model 4612	100 to 12,000 cpm; varies with calibration γ	N/A	~1,000 cpm γ
	Geiger-Mueller Ludlum Model 44-40		40 – 50 cpm β	~22.3 β efficiency	500 cpm β
Surface gamma scans	NaI 2-inch x 2-inch scintillation Ludlum Model 44-10	Data logger 2350-1, 4612	100 to 12,000 cpm; varies with calibration γ	N/A	150-1500 cpm γ
Direct measurement static gamma					
Surface beta/gamma scans	Geiger-Mueller 44-9	Ratemeter 3	50 to 100 cpm β γ	~ 10 β γ total efficiency	~1,000 dpm per probe area β γ
Direct measurement beta/gamma					
Exposure rates	MicroR Meter with integral 1-inch x 1-inch NaI Scintillation	Ratemeter 19	7-8 μR/hr	N/A	2 μR/hr

Abbreviations and Acronyms:

α – alpha
β – beta
γ – gamma
μR/hr – microroentgen per hour
cm^2 – square centimeters
cpm – count per minute
dpm – disintegration per minute
N/A – not applicable
NaI – sodium iodide

TABLE 4-4

IR-02 POST-EXCAVATION HOT SPOT LOG

Surveyor	Date	2350-1 Instrument Serial Number	Grid #	Espinoza Flag ID #	Background Instrument 3s Investigation Level (cpm)	Towed Array Gamma Reading (cpm)	Initial 1-Minute Static Gamma Reading (cpm)	1-Foot Static Gamma Reading (cpm)	Final Depth (feet)	Final Static Gamma Reading (cpm)
Rick Zahensky	10/16/2006	228706	103	32601	6,428	36,910	7,180*W	3950*W	0.77	3950*W
Rick Zahensky	10/16/2006	228706	103	32603	6,428	39,830	8,060*W	3890*W	0.81	3890*W
Rick Zahensky	10/16/2006	228706	103	32597	6,428	28,120	7,600*W	4,360	1.22	4360*W
Rick Zahensky	10/16/2006	228706	103	32607	6,428	39,980	17,500*W	3,160	1.28	3160*W
Rick Zahensky	10/16/2006	228706	103	32608	6,428	43,810	18,400*W	3,140	1.05	3140*W
Rick Zahensky	10/16/2006	228706	103	32609	6,428	44,050	20,200*W	4,490	1.01	4490*W
Rick Zahensky	10/16/2006	228706	103	32613	6,428	61,370	20,900*W	6080*W	0.57	6080*W
Rick Zahensky	10/16/2006	228706	103	32615	6,428	108,030	21,900*W	4960*W	0.86	4960*W
Rick Zahensky	10/17/2006	228706	103	32668	6,428	25,900	6,720*W	4220*W	0.95	4220*W
Rick Zahensky	10/17/2006	228706	104	32670	6,428	46,790	19,700*W	3,290	1.33	3290*W
Rick Zahensky	10/17/2006	228706	104	32671	6,428	64,350	30,300	7,510	1.58	7,510
Rick Zahensky	10/17/2006	228706	104	32674	6,428	25,030	11,600*W	3760*W	0.76	3760*W
Rick Zahensky	10/16/2006	228706	105	32593	6,428	In Water	43,700*W	2,800	1.12	2800*W
Rick Zahensky	10/16/2006	228706	105	32595	6,428	In Water	24,800*W	4160*W	0.89	4160*W
Rick Zahensky	10/9/2006	221013	107	31644	7,284	11,640	23,500	5,020	0.60	5,020
Rick Zahensky	10/16/2006	228706	122	31645	6,428	59,750	37,800	6,720	0.44	6,720
Rick Zahensky	10/18/2006	228706	124	31646	6,428	49,390	71,100	8,610	0.81	8,610
Rick Zahensky	10/16/2006	228706	124	31649	6,428	100,630	72,300	5,530	0.54	5,530
Rick Zahensky	10/18/2006	228706	124	31647	6,428	33,140	59,700	6,680	0.97	6,680
Rick Zahensky	10/18/2006	228706	124	31648	6,428	23,270	34,800	5,740	0.67	5,740
Rick Zahensky	10/10/2006	228709	125	31956	6,622	22,140	35,800	5,760	0.75	5,760

TABLE 4-4

IR-02 POST-EXCAVATION HOT SPOT LOG

Surveyor	Date	2350-1 Instrument Serial Number	Grid #	Espinoza Flag ID #	Background Instrument 3s Investigation Level (cpm)	Towed Array Gamma Reading (cpm)	Initial 1-Minute Static Gamma Reading (cpm)	1-Foot Static Gamma Reading (cpm)	Final Depth (feet)	Final Static Gamma Reading (cpm)
Rick Zahensky	10/16/2006	228706	125	32599	6,428	61,960	124,000	5270*W	0.56	5270*W
Rick Zahensky	10/17/2006	228706	126	32675	6,428	48,530	84,000*W	5,630	1.31	5630*W
Rick Zahensky	10/10/2006	228709	126	31958	6,622	13,900	16,200	7,060	0.87	7,060
Rick Zahensky	10/17/2006	228706	126	32676	6,428	91,230	91,900*W	3930*W	0.70	3930*W
Rick Zahensky	10/17/2006	228706	126	32678	6,428	14,780	25,500	6,210	0.37	6,210
Rick Zahensky	10/17/2006	228706	126	32679	6,428	22,640	36,400*W	5730*W	0.73	5730*W
Rick Zahensky	10/17/2006	228706	127	32684	6,428	73,730	74,100*W	3650*W	0.63	3650*W
Rick Zahensky	10/17/2006	228706	127	32686	6,428	15,440	28,000*W	3980*W	0.61	3980*W
Rick Zahensky	10/17/2006	228706	127	32688	6,428	78,050	143,800*W	3450*W	0.34	3450*W
Rick Zahensky	10/17/2006	228706	127	32689	6,428	17,700	12,200*W	4350*W	0.62	4350*W
Rick Zahensky	10/11/2006	228709	129-1	31984	6,622	20,190	62,500	5,840	0.76	5,840
Rick Zahensky	10/17/2006	228706	129-1	32702	6,428	21,480	41,400*W	3830*W	0.81	3830*W
Rick Zahensky	10/18/2006	228706	129-1	32711	6,428	23,160	36,100*W	4530*W	0.87	4530*W
Rick Zahensky	10/17/2006	228706	129-1	32704	6,428	42,550	79,800*W	5090*W	0.74	5090*W
Rick Zahensky	10/17/2006	228706	129-1	32706	6,428	27,810	74,800*W	3080*W	0.75	3080*W
Rick Zahensky	10/10/2006	228709	130	31960	6,622	12,740	27,200	7,240	1.38	7,240
Rick Zahensky	10/17/2006	228706	130	32694	6,428	14,820	28,500	9,460	0.38	9,460
Rick Zahensky	10/17/2006	228706	130	32695	6,428	58,180	86,500*W	5	0.75	5
Rick Zahensky	10/17/2006	228706	130	32697	6,428	23,310	58,800	6,430	0.44	6,430
Rick Zahensky	10/17/2006	228706	130	32700	6,428	37,760	44,400	4,570	0.69	4,570
Rick Zahensky	10/11/2006	228709	130	31967	6,622	21,380	36,700	4,630	0.81	4,630

TABLE 4-4

IR-02 POST-EXCAVATION HOT SPOT LOG

Surveyor	Date	2350-1 Instrument Serial Number	Grid #	Espinoza Flag ID #	Background Instrument 3s Investigation Level (cpm)	Towed Array Gamma Reading (cpm)	Initial 1-Minute Static Gamma Reading (cpm)	1-Foot Static Gamma Reading (cpm)	Final Depth (feet)	Final Static Gamma Reading (cpm)
Rick Zahensky	10/10/2006	228709	130	31963	6,622	29,190	42,300	5,250	1.15	5,250
Rick Zahensky	10/10/2006	228709	130	31965	6,622	15,200	29,800	5,530	0.82	5,530
Rick Zahensky	10/9/2006	228709	131	31691	6,622	40,060	37,100	10,400	0.94	10,400
Rick Zahensky	10/9/2006	228709	131	31692	6,622	107,320	52,700	7,380	0.73	7,380
Rick Zahensky	10/9/2006	228709	131	31693	6,622	20,620	19,000	11,700	0.70	11,700
Rick Zahensky	10/9/2006	228709	131	31694	6,622	22,760	24,500	6,100	0.76	6,100
Rick Zahensky	10/9/2006	228709	131	31707	6,622	86,690	54,500	5,530	1.01	5,530
Rick Zahensky	10/9/2006	228709	131	31699	6,622	48,670	40,500	12,500	1.08	12,500
Rick Zahensky	10/9/2006	228709	131	31700	6,622	92,900	72,500	9,490	1.38	9,490
Rick Zahensky	10/9/2006	228709	131	31701	6,622	26,020	27,700	5,030	0.41	5,030
Rick Zahensky	10/17/2006	228706	131	32692	6,428	15,650	15,600	7,270	0.58	7,270
Rick Zahensky	10/9/2006	228709	131	31702	6,622	15,930	17,900	5,370	0.60	5,370
Rick Zahensky	10/9/2006	228709	131	31703	6,622	22,890	26,900	5,810	0.75	5,810
Rick Zahensky	10/9/2006	228709	131	31704	6,622	16,190	16,700	11,100	0.72	11,100
Rick Zahensky	10/9/2006	228709	131	31706	6,622	223,440	263,450	6,540	1.41	6,540
Rick Zahensky	10/9/2006	228709	131	31705	6,622	19,540	20,300	5,470	1.34	5,470
Rick Zahensky	10/9/2006	228709	132	31685	6,622	43,880	36,700	8,090	0.58	8,090
Rick Zahensky	10/9/2006	228709	132	31686	6,622	33,240	20,600	6,440	0.68	6,440
Rick Zahensky	10/9/2006	228709	132	31687	6,622	33,670	38,300	8,020	0.77	8,020
Rick Zahensky	10/9/2006	228709	133	31651	6,622	28,990	48,100	11,500	0.85	11,500
Rick Zahensky	10/9/2006	228709	133	31652	6,622	31,490	73,400	5,750	0.82	5,750

TABLE 4-4

IR-02 POST-EXCAVATION HOT SPOT LOG

Surveyor	Date	2350-1 Instrument Serial Number	Grid #	Espinoza Flag ID #	Background Instrument 3s Investigation Level (cpm)	Towed Array Gamma Reading (cpm)	Initial 1-Minute Static Gamma Reading (cpm)	1-Foot Static Gamma Reading (cpm)	Final Depth (feet)	Final Static Gamma Reading (cpm)
Rick Zahensky	10/9/2006	228709	133	31657	6,622	18,140	22,800	8,000	1.09	8,040
Rick Zahensky	10/9/2006	228709	133	31658	6,622	20,550	26,300	8,480	1.19	8,480
Rick Zahensky	10/9/2006	228709	133	31661	6,622	18,480	16,500	6,960	0.99	6,960
Rick Zahensky	10/9/2006	228709	133	31662	6,622	19,840	35,600	25,000	2.38	9,400
Rick Zahensky	10/9/2006	228709	133	31663	6,622	19,430	23,100	7,440	1.40	7,440
Rick Zahensky	10/9/2006	228709	133	31664	6,622	25,790	37,000	6,740	1.09	6,740
Rick Zahensky	10/9/2006	228709	133	31669	6,622	48,660	57,300	5,320	0.80	5,320
Rick Zahensky	10/9/2006	228709	133	31670	6,622	21,530	24,000	5,280	0.93	5,280
Rick Zahensky	10/9/2006	228709	133	31671	6,622	21,540	21,200	6,610	1.30	6,610
Rick Zahensky	10/9/2006	228709	133	31677	6,622	23,060	23,600	10,000	0.56	10,000
Rick Zahensky	10/9/2006	228709	133	31679	6,622	23,290	46,900	6,130	1.05	6,130
Rick Zahensky	10/9/2006	228709	133	31680	6,622	23,900	48,400	6,470	0.94	6,470
Rick Zahensky	10/9/2006	228709	133	31681	6,622	42,330	72,900	5,560	0.70	5,560
Rick Zahensky	10/16/2006	228706	134	32587	6,428	24,020	68,100	3,870	0.74	3,870
Rick Zahensky	10/9/2006	228709	134	31675	6,622	31,550	39,400	7,470	0.71	7,470
Rick Zahensky	10/16/2006	228706	134	32588	6,428	17,260	21,600	6,000	0.82	6,000
Rick Zahensky	10/16/2006	228706	152	32577	6,428	12,620	308,000	8,200	1.37	8,200
Rick Zahensky	10/16/2006	228706	153	32581	6,428	54,350	55,100	5,690	0.70	5,690
Rick Zahensky	10/9/2006	228709	153	31653	6,622	19,470	21,400	10,200	0.90	10,200
Rick Zahensky	10/16/2006	228706	153	32583	6,428	15,660	17,700	4,960	0.74	4,960
Rick Zahensky	10/16/2006	228706	153	32585	6,428	25,070	25,700	5,480	0.72	5,480

TABLE 4-4

IR-02 POST-EXCAVATION HOT SPOT LOG

Surveyor	Date	2350-1 Instrument Serial Number	Grid #	Espinoza Flag ID #	Background Instrument 3s Investigation Level (cpm)	Towed Array Gamma Reading (cpm)	Initial 1-Minute Static Gamma Reading (cpm)	1-Foot Static Gamma Reading (cpm)	Final Depth (feet)	Final Static Gamma Reading (cpm)
Rick Zahensky	10/11/2006	228709	154	31992	6,622	46,980	30,900	6,090	0.45	6,090
Rick Zahensky	10/11/2006	228709	154	31991	6,622	53,480	20,900	6,670	0.74	6,670
Rick Zahensky	10/9/2006	228709	155	31714	6,622	32,230	34,800	6,530	1.03	6,530
Rick Zahensky	10/9/2006	228709	155	31716	6,622	38,960	63,400	5,710	1.56	5,710
Rick Zahensky	10/10/2006	228709	156	31969	6,622	21,000	23,400	4,360	0.90	4,360
Rick Zahensky	10/10/2006	228709	156	31971	6,622	22,040	19,700	7,300	1.08	7,300
Rick Zahensky	10/10/2006	228709	156	31973	6,622	42,300	31,800	5,280	0.90	5,280
Rick Zahensky	10/11/2006	228709	157	31977	6,622	16,250	20,000	9,700	1.03	9,700
Rick Zahensky	10/10/2006	228709	157	31978	6,622	16,890	22,400	7,350	0.97	7,350
Rick Zahensky	10/10/2006	228709	157	31979	6,622	10,690	38,000	4,200	1.16	4,200
Rick Zahensky	10/10/2006	228709	157	31975	6,622	24,090	41,100	6,080	0.99	6,080
Rick Zahensky	10/18/2006	228706	157	32710	6,428	65,890	39,400*W	4,150	0.56	4,150
Rick Zahensky	10/11/2006	228709	157	32090	6,622	44,840	22,300	1,120	1.42	1,120
Rick Zahensky	10/11/2006	228709	157	31639	6,622	11,960	20,400	8,780	0.79	8,780
Rick Zahensky	10/18/2006	228706	157-1	32708	6,428	In Water	22,500*W	4,130	1.64	4130*W
Rick Zahensky	10/18/2006	228706	157-1	31641	6,428	In Water	84,100*W	3,690	1.15	3690*W
Rick Zahensky	10/18/2006	228706	157-1	31642	6,428	In Water	59,900*W	4,760	1.55	4760*W
Rick Zahensky	10/18/2006	228706	159	32716	6,428	12,620	19,200	9,950	0.76	9,950
Rick Zahensky	10/11/2006	228709	161	31638	6,622	16,110	16,500	6,440	0.50	6,440
Rick Zahensky	10/11/2006	228709	161	31637	6,622	22,670	25,800	6,360	0.76	6,360
Rick Zahensky	10/11/2006	228709	161	31636	6,622	22,690	26,200	9,720	0.75	9,720

TABLE 4-4

IR-02 POST-EXCAVATION HOT SPOT LOG

Surveyor	Date	2350-1 Instrument Serial Number	Grid #	Espinoza Flag ID #	Background Instrument 3s Investigation Level (cpm)	Towed Array Gamma Reading (cpm)	Initial 1-Minute Static Gamma Reading (cpm)	1-Foot Static Gamma Reading (cpm)	Final Depth (feet)	Final Static Gamma Reading (cpm)
Rick Zahensky	10/11/2006	228709	161	30973	6,622	16,580	15,400	12,300	0.68	12,300
Rick Zahensky	10/11/2006	228709	161	30972	6,622	53,510	32,800	3,550	1.23	3,550
Rick Zahensky	10/11/2006	228709	161	30971	6,622	17,430	16,900	2,750	1.12	2,750
Rick Zahensky	10/11/2006	228709	161	32114	6,622	17,620	16,800	8,160	1.39	8,160
Rick Zahensky	10/11/2006	228709	161	30970	6,622	21,800	21,100	2,480	1.43	2,480
Rick Zahensky	10/11/2006	228709	161	30969	6,622	17,260	25,200	5,770	1.95	5,770
Rick Zahensky	10/11/2006	228709	161	30968	6,622	20,230	21,800	7,180	1.32	7,180
Rick Zahensky	10/11/2006	228709	161	30967	6,622	20,920	28,500	2,320	1.85	2,320
Rick Zahensky	10/11/2006	228709	161	30966	6,622	16,760	15,500	8,850	1.27	8,850
Rick Zahensky	10/11/2006	228709	161	30965	6,622	18,620	30,500	5,630	0.63	5,630
Rick Zahensky	10/11/2006	228709	161	30964	6,622	53,030	52,100	8,300	0.91	8,300
Rick Zahensky	10/11/2006	228709	161	30963	6,622	27,160	27,700	2,520	1.51	2,520
Rick Zahensky	10/11/2006	228709	161	30962	6,622	56,960	51,500	1,280	1.36	1,280
Rick Zahensky	10/11/2006	228709	161	30961	6,622	24,660	19,500	1,690	1.49	1,690
Rick Zahensky	10/13/2006	228709	161	30958	6,622	22,840	22,200	2,000	2.15	2,000
Rick Zahensky	10/11/2006	228709	161	30960	6,622	19,820	20,000	2,150	1.45	2,150
Rick Zahensky	10/11/2006	228709	161	30959	6,622	24,010	23,100	3,560	1.36	3,560
Rick Zahensky	10/11/2006	228709	161	30957	6,622	23,580	21,700	5,500	0.93	5,500
Rick Zahensky	10/13/2006	228709	162	32113	6,622	17,300	19,700	12,200	1.54	12,200
Rick Zahensky	10/13/2006	228709	162	30956	6,622	21,970	34,200	1,320	1.44	1,320
Rick Zahensky	10/13/2006	228709	162	30955	6,622	63,010	17,300	9,730	0.99	9,730

TABLE 4-4

IR-02 POST-EXCAVATION HOT SPOT LOG

Surveyor	Date	2350-1 Instrument Serial Number	Grid #	Espinoza Flag ID #	Background Instrument 3s Investigation Level (cpm)	Towed Array Gamma Reading (cpm)	Initial 1-Minute Static Gamma Reading (cpm)	1-Foot Static Gamma Reading (cpm)	Final Depth (feet)	Final Static Gamma Reading (cpm)
Rick Zahensky	10/13/2006	228709	162	30954	6,622	18,500	17,800	9,870	0.99	9,870
Rick Zahensky	10/13/2006	228709	162	30953	6,622	42,020	48,100	9,560	0.83	9,560
Rick Zahensky	10/13/2006	228709	162	30952	6,622	15,200	15,000	2,130	0.73	2,130
Rick Zahensky	10/13/2006	228709	162	30951	6,622	17,530	16,000	1,580	2.43	1,580
Rick Zahensky	10/13/2006	228709	162	30950	6,622	19,020	21,700	7,770	0.80	7,770
Rick Zahensky	10/13/2006	228709	162	30949	6,622	36,600	48,900	9,980	1.24	9,980
Rick Zahensky	10/13/2006	228709	162	30948	6,622	17,520	16,700	1,200	1.12	1,200
Rick Zahensky	10/13/2006	228709	162	30947	6,622	19,150	15,220	1,120	0.95	1,120
Rick Zahensky	10/13/2006	228709	162	30946	6,622	33,210	33,600	7,190	1.56	7,190
Rick Zahensky	10/13/2006	228709	162	30945	6,622	63,010	72,500	1,050	0.89	1,050
Rick Zahensky	10/13/2006	228709	163	30944	6,622	30,918	23,800	6,490	1.01	6,490
Rick Zahensky	10/13/2006	228709	163	30943	6,622	504,140	28,300	5,300	1.16	5300*W
Rick Zahensky	10/13/2006	228709	163	30942	6,622	612,350	50,400	4,250	1.19	4250*W
Rick Zahensky	10/13/2006	228709	164	30941	6,622	37,570	17,300	2,860	1.96	2860*W
Rick Zahensky	10/16/2006	228706	164	32579	6,428	37,850	30,300*W	1,150	1.46	1150*W
Rick Zahensky	10/13/2006	228709	164	30940	6,622	55,800	50,100	2,750	2.79	2750*W
Rick Zahensky	10/16/2006	228706	164	32575	6,428	28,480	16,500	5,090	1.24	5090*W

Abbreviations and Acronyms:

* – Static taken above 6 inches of water
cpm – count per minute
ID – identification
W – Static taken above water

TABLE 4-5

RANDOM GRID POST-EXCAVATION SAMPLE QA COMPARISON

Sample ID	Location	On-site Laboratory						Off-site Laboratory (QA)						
		^{137}Cs			^{226}Ra			Count Time (min.)	^{137}Cs			^{226}Ra		
		Activity	MDA	2σ Error	Activity	MDA	2σ Error		Activity	MDA	2σ Error	Activity	MDA	2σ Error
72NIR02G72PE-001	Grid 72	0.002	0.014	0.016	0.144	0.478	0.532	249	U	0.030	N/A	0.185	0.055	0.075
72NIR02G95PE-001	Grid 95	-0.058	0.045	-0.874	0.597	1.080	1.230	201	U	0.051	N/A	0.356	0.095	0.110
72NIR02G101PE-001	Grid 101	-0.031	0.034	-0.145	0.574	0.671	0.785	230	U	0.025	N/A	0.389	0.054	0.097
72NIR02G122PE-001	Grid 122	-0.070	0.055	127.620	0.490	1.200	1.408	219	U	0.029	N/A	0.351	0.058	0.080
72NIR02G127PE-001	Grid 127	0.012	0.025	0.031	3.783	0.719	0.962	225	U	0.057	N/A	2.090	0.124	0.350
72NIR02G135PE-001	Grid 135	-0.023	0.053	-0.055	0.692	1.130	1.307	202	U	0.047	N/A	0.429	0.095	0.130
72NIR02G138PE-001	Grid 138	-0.026	0.044	-0.108	0.403	1.070	1.259	311	U	0.021	N/A	0.333	0.048	0.071
72NIR02G159PE-001	Grid 159	0.026	0.044	0.049	-0.505	0.798	-1.792	202	U	0.027	N/A	0.212	0.056	0.064
72NIR02G183PE-001	Grid 183	0.033	0.019	0.028	-0.946	0.767	-5.015	230	U	0.044	N/A	0.142	0.076	0.070

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDA – minimum detectable activity
min. – minutes
N/A – 2 sigma error not reported since the activity was less than MDA
QA – quality assurance
^{226}Ra – radium-226
U – activity not reported since it was less than MDA

TABLE 4-6

SIDEWALL POST-EXCAVATION SAMPLE QA COMPARISON

Sample ID	Location	On-site Laboratory						Off-site Laboratory (QA)						
		^{137}Cs			^{226}Ra			Count Time (min.)	^{137}Cs			^{226}Ra		
		Activity	MDA	2σ Error	Activity	MDA	2σ Error		Activity	MDA	2σ Error	Activity	MDA	2σ Error
72NIR02G66SWPE-001	Grid 66	-0.004	0.047	-0.048	-0.219	1.050	-1.489	356	U	0.021	N/A	0.169	0.053	0.061
72NIR02G67ASWPE-001	Grid 67	0.089	0.043	0.077	-0.849	1.290	-3.110	216	U	0.029	N/A	0.509	0.054	0.098

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDA – minimum detectable activity
min. – minutes
N/A – 2 sigma error not reported since the activity was less than MDA
QA – quality assurance
^{226}Ra – radium-226
U – activity not reported since it was less than MDA

TABLE 4-7

SYSTEMATIC GRID POST-EXCAVATION SAMPLE QA COMPARISON

Sample ID	On-site Laboratory						Off-site Laboratory (QA)						
	^{137}Cs			^{226}Ra			Count Time (min.)	^{137}Cs			^{226}Ra		
	Activity	MDA	3σ Error	Activity	MDA	3σ Error		Activity	MDA	2σ Error	Activity	MDA	2σ Error
72NIR02SU1B2PE-001	-0.035	0.039	-0.144	0.274	0.992	1.113	357	U	0.038	N/A	0.254	0.040	0.075
72NIR02SU1D3PE-001	0.025	0.026	0.033	1.663	0.675	0.829	233	U	0.050	N/A	0.627	0.097	0.140
72NIR02SU3D2PE-001	-0.005	0.043	-0.058	0.761	0.826	0.971	843	U	0.012	N/A	0.202	0.025	0.039
72NIR02SU4F2PE-001	0.013	0.021	0.025	0.123	0.537	0.580	843	U	0.019	N/A	0.190	0.034	0.056
72NIR02SU4F3PE-001	-0.013	0.043	122.040	0.055	1.000	1.196	250	U	0.036	N/A	0.213	0.071	0.100
72NIR02SU5D1PE-001	-0.009	0.029	78.963	-0.104	0.769	-0.965	238	U	0.026	N/A	0.178	0.051	0.061
72NIR02SU6C3PE-001	0.003	0.029	0.033	0.215	0.921	1.018	356	U	0.041	N/A	0.319	0.082	0.097
72NIR02SU6D1PE-001	0.013	0.041	0.041	0.960	0.901	1.059	237	U	0.037	N/A	0.487	0.069	0.110
72NIR02SU8E2PE-001	0.007	0.047	0.050	0.242	1.220	1.381	1023	U	0.013	N/A	0.517	0.028	0.085
72NIR02SU9A1PE-001	0.007	0.022	0.027	-0.456	0.712	-1.346	249	U	0.024	N/A	0.137	0.046	0.049
72NIR02SU9B2PE-001	-0.053	0.046	-1.047	-0.042	1.040	-1.244	843	U	0.040	N/A	0.449	0.031	0.090
72NIR02SU9D3PE-001	-0.034	0.049	-0.186	0.426	1.060	1.244	219	U	0.029	N/A	0.189	0.060	0.071
72NIR02SU9E3PE-001	-0.050	0.042	-0.448	0.291	0.959	1.116	219	U	0.036	N/A	0.182	0.060	0.076

Abbreviations and Acronyms:

^{137}Cs – cesium-137
MDA – minimum detectable activity
min. – minutes
N/A – 2 sigma error not reported since the activity was less than MDA
QA – quality assurance
^{226}Ra – radium-226
U – activity not reported since it was less than MDA

TABLE 4-8

RADIOLOGICAL SAMPLE LOCATIONS AND IDENTIFIERS

Map ID	Sample ID
R067PE	72NIR02G67PE-001
R070PE	72NIR02G70PE-001
R071PE	72NIR02G71PE-001
R072PE	72NIR02G72PE-001
R073PE	72NIR02G73PE-001
R092PE	72NIR02G92PE-001
R093PE	72NIR02G93PE-001
R094PE	72NIR02G94PE-001
R095PE	72NIR02G95PE-001
R096PE	72NIR02G96PE-001
R097PE	72NIR02G97PE-001
R101PE	72NIR02G101PE-001
R102PE	72NIR02G102PE-001
R103PE	72NIR02G103PE-001
R104PE	72NIR02G104PE-001
R105PE	72NIR02G105PE-001
R106PE	72NIR02G106PE-001
R107PE	72NIR02G107PE-001
R121PE	72NIR02G121PE-001
R122PE	72NIR02G122PE-001
R123PE	72NIR02G123PE-001
R124PE	72NIR02G124PE-001
R125PE	72NIR02G125PE-001
R126PE	72NIR02G126PE-001
R127PE	72NIR02G127PE-001
R128PE	72NIR02G128PE-001
R129PE	72NIR02G129PE-001
R129-1PE	72NIR02G129-1PE-001
R130PE	72NIR02G130PE-001
R131PE	72NIR02G131PE-001
R132PE	72NIR02G132PE-001
R133PE	72NIR02G133PE-001
R134PE	72NIR02G134PE-001
R135PE	72NIR02G135PE-001
R136PE	72NIR02G136PE-001
R137PE	72NIR02G137PE-001
R138PE	72NIR02G138PE-001
R149PE	72NIR02G149PE-001
R150PE	72NIR02G150PE-001
R151PE	72NIR02G151PE-001
R152PE	72NIR02G152PE-001
R153PE	72NIR02G153PE-001
R154PE	72NIR02G154PE-001
R155PE	72NIR02G155PE-001
R156PE	72NIR02G156PE-001
R157PE	72NIR02G157PE-001
R157-1PE	72NIR02G157-1PE-001
R157-2PE	72NIR02G157-2PE-001
R158PE	72NIR02G158PE-001
R159PE	72NIR02G159PE-001
R160PE	72NIR02G160PE-001

Map ID	Sample ID
R161PE	72NIR02G161PE-001
R162PE	72NIR02G162PE-001
R163PE	72NIR02G163PE-001
R164PE	72NIR02G164PE-001
R165PE	72NIR02G165PE-001
R166PE	72NIR02G166PE-001
R177PE	72NIR02G177PE-001
R178PE	72NIR02G178PE-001
R179PE	72NIR02G179PE-001
R182PE	72NIR02G182PE-001
R183PE	72NIR02G183PE-001
R184PE	72NIR02G184PE-001
RSW0910A	72NIR02G66SWPE-001
RSW1011A	72NIR02G67SWPE-001
RSW1112A	72NIR02G67SWPE-002
RSW1213A	72NIR02G70SWPE-001
RSW1314A	72NIR02G70SWPE-002
RSW0809A	72NIR02G73SWPE-001
RSW0506A	72NIR02G91SWPE-001
RSW0607A	72NIR02G92SWPE-001
RSW0708A	72NIR02G93SWPE-001
RSW1516A	72NIR02G100SWPE-001
RSW1415A	72NIR02G101SWPE-001
RSW0405A	72NIR02G108SWPE-002
RSW1030A	72NIR02G121SWPE-001
RSW1617A	72NIR02G129SWPE-001
RSW0203A	72NIR02G138SWPE-001
RSW0102A	72NIR02G149SWPE-001
RSW1718A	72NIR02G157-1SWPE-001
RSW1819A	72NIR02G157-2SWPE-001
RSW1920A	72NIR02G157-2SWPE-002
RSW2901A	72NIR02G166SWPE-001
RSW2829A	72NIR02G176SWPE-001
RSW2728A	72NIR02G178SWPE-001
RSW2627A	72NIR02G179SWPE-001
RSW2425A	72NIR02G180SWPE-001
RSW2526A	72NIR02G180SWPE-002
RSW2324A	72NIR02G182SWPE-001
RSW2223A	72NIR02G183SWPE-001
RSW2122A	72NIR02G183SWPE-002
RSW2021A	72NIR02G184SWPE-001
SU01-A0	72NIR02SU1A0PE-001
SU01-A1	72NIR02SU1A1PE-001
SU01-B0	72NIR02SU1B0PE-001
SU01-B1	72NIR02SU1B1PE-001
SU01-B2	72NIR02SU1B2PE-001
SU01-C1	72NIR02SU1C1PE-001
SU01-C2	72NIR02SU1C2PE-001
SU01-C3	72NIR02SU1C3PE-001
SU01-D1	72NIR02SU1D1PE-001
SU01-D2	72NIR02SU1D2PE-001

Map ID	Sample ID
SU01-D3	72NIR02SU1D3PE-001
SU01-D4	72NIR02SU1D4PE-001
SU01-E3	72NIR02SU1E3PE-001
SU01-E4	72NIR02SU1E4PE-001
SU01-E5	72NIR02SU1E5PE-001
SU01-F4	72NIR02SU1F4PE-001
SU01-F5	72NIR02SU1F5PE-001
SU02-A0	72NIR02SU2A0PE-001
SU02-B0	72NIR02SU2B0PE-001
SU02-B1	72NIR02SU2B1PE-001
SU02-C1	72NIR02SU2C1PE-001
SU02-C2	72NIR02SU2C2PE-001
SU02-D2	72NIR02SU2D2PE-001
SU02-D3	72NIR02SU2D3PE-001
SU02-E3	72NIR02SU2E3PE-001
SU02-E4	72NIR02SU2E4PE-001
SU02-F3	72NIR02SU2F3PE-001
SU02-F4	72NIR02SU2F4PE-001
SU02-F5	72NIR02SU2F5PE-001
SU02-G4	72NIR02SU2G4PE-001
SU02-G5	72NIR02SU2G5PE-001
SU02-G6	72NIR02SU2G6PE-001
SU02-H5	72NIR02SU2H5PE-001
SU03-A3	72NIR02SU3A3PE-001
SU03-B1	72NIR02SU3B1PE-001
SU03-B2	72NIR02SU3B2PE-001
SU03-B3	72NIR02SU3B3PE-001
SU03-B4	72NIR02SU3B4PE-001
SU03-C0	72NIR02SU3C0PE-001
SU03-C1	72NIR02SU3C1PE-001
SU03-C2	72NIR02SU3C2PE-001
SU03-C3	72NIR02SU3C3PE-001
SU03-C4	72NIR02SU3C4PE-001
SU03-C5	72NIR02SU3C5PE-001
SU03-D1	72NIR02SU3D1PE-001
SU03-D2	72NIR02SU3D2PE-001
SU03-D3	72NIR02SU3D3PE-001
SU03-D4	72NIR02SU3D4PE-001
SU03-E2	72NIR02SU3E2PE-001
SU04-A4	72NIR02SU4A4PE-001
SU04-B3	72NIR02SU4B3PE-001
SU04-C1	72NIR02SU4C1PE-001
SU04-C2	72NIR02SU4C2PE-001
SU04-C3	72NIR02SU4C3PE-001
SU04-D0	72NIR02SU4D0PE-001
SU04-D1	72NIR02SU4D1PE-001
SU04-D2	72NIR02SU4D2PE-001
SU04-D3	72NIR02SU4D3PE-001
SU04-E1	72NIR02SU4E1PE-001
SU04-E2	72NIR02SU4E2PE-001
SU04-E3	72NIR02SU4E3PE-001

Map ID	Sample ID
SU04-E4	72NIR02SU4E4PE-001
SU04-F2	72NIR02SU4F2PE-001
SU04-F3	72NIR02SU4F3PE-001
SU04-G2	72NIR02SU4G2PE-001
SU05-A2	72NIR02SU5A2PE-001
SU05-B1	72NIR02SU5B1PE-001
SU05-B2	72NIR02SU5B2PE-001
SU05-B3	72NIR02SU5B3PE-001
SU05-C0	72NIR02SU5C0PE-001
SU05-C1	72NIR02SU5C1PE-001
SU05-C2	72NIR02SU5C2PE-001
SU05-C3	72NIR02SU5C3PE-001
SU05-C4	72NIR02SU5C4PE-001
SU05-D0	72NIR02SU5D0PE-001
SU05-D1	72NIR02SU5D1PE-001
SU05-D2	72NIR02SU5D2PE-001
SU05-D3	72NIR02SU5D3PE-001
SU05-D4	72NIR02SU5D4PE-001
SU05-E1	72NIR02SU5E1PE-001
SU05-E2	72NIR02SU5E2PE-001
SU06-A3	72NIR02SU6A3PE-001
SU06-B1	72NIR02SU6B1PE-001
SU06-B2	72NIR02SU6B2PE-001
SU06-B3	72NIR02SU6B3PE-001
SU06-B4	72NIR02SU6B4PE-001
SU06-C0	72NIR02SU6C0PE-001
SU06-C1	72NIR02SU6C1PE-001
SU06-C2	72NIR02SU6C2PE-001
SU06-C3	72NIR02SU6C3PE-001
SU06-C4	72NIR02SU6C4PE-001
SU06-D1	72NIR02SU6D1PE-001
SU06-D2	72NIR02SU6D2PE-001
SU06-D3	72NIR02SU6D3PE-001
SU06-D4	72NIR02SU6D4PE-001
SU06-E2	72NIR02SU6E2PE-001
SU06-E3	72NIR02SU6E3PE-001
SU07-A2	72NIR02SU7A2PE-001
SU07-B1	72NIR02SU7B1PE-001
SU07-B2	72NIR02SU7B2PE-001
SU07-B3	72NIR02SU7B3PE-001
SU07-C0	72NIR02SU7C0PE-001
SU07-C1	72NIR02SU7C1PE-001
SU07-C2	72NIR02SU7C2PE-001
SU07-C3	72NIR02SU7C3PE-001
SU07-C4	72NIR02SU7C4PE-001
SU07-D1	72NIR02SU7D1PE-001
SU07-D2	72NIR02SU7D2PE-001
SU07-D3	72NIR02SU7D3PE-001
SU07-D4	72NIR02SU7D4PE-001
SU07-E1	72NIR02SU7E1PE-001
SU07-E2	72NIR02SU7E2PE-001

Map ID	Sample ID
SU07-E3	72NIR02SU7E3PE-001
SU08-A1	72NIR02SU8A1PE-001
SU08-A2	72NIR02SU8A2PE-001
SU08-A3	72NIR02SU8A3PE-001
SU08-B0	72NIR02SU8B0PE-001
SU08-B1	72NIR02SU8B1PE-001
SU08-B2	72NIR02SU8B2PE-001
SU08-B3	72NIR02SU8B3PE-001
SU08-B4	72NIR02SU8B4PE-001
SU08-C1	72NIR02SU8C1PE-001
SU08-C2	72NIR02SU8C2PE-001
SU08-C3	72NIR02SU8C3PE-001
SU08-C4	72NIR02SU8C4PE-001
SU08-D1	72NIR02SU8D1PE-001
SU08-D2	72NIR02SU8D2PE-001
SU08-D3	72NIR02SU8D3PE-001
SU08-E2	72NIR02SU8E2PE-001
SU09-A1	72NIR02SU9A1PE-001
SU09-B0	72NIR02SU9B0PE-001
SU09-B1	72NIR02SU9B1PE-001
SU09-B2	72NIR02SU9B2PE-001
SU09-C1	72NIR02SU9C1PE-001
SU09-C2	72NIR02SU9C2PE-001
SU09-D2	72NIR02SU9D2PE-001
SU09-D3	72NIR02SU9D3PE-001
SU09-E3	72NIR02SU9E3PE-001
SU09-E4	72NIR02SU9E4PE-001
SU09-F4	72NIR02SU9F4PE-001
SU09-F5	72NIR02SU9F5PE-001
SU09-G4	72NIR02SU9G4PE-001
SU09-G5	72NIR02SU9G5PE-001
SU09-G6	72NIR02SU9G6PE-001
SU09-H5	72NIR02SU9H5PE-001
SU10-A0	72NIR02SU10A0PE-001
SU10-A1	72NIR02SU10A1PE-001
SU10-B0	72NIR02SU10B0PE-001
SU10-B1	72NIR02SU10B1PE-001
SU10-B2	72NIR02SU10B2PE-001
SU10-C1	72NIR02SU10C1PE-001
SU10-C2	72NIR02SU10C2PE-001
SU10-C3	72NIR02SU10C3PE-001
SU10-D1	72NIR02SU10D1PE-001
SU10-D2	72NIR02SU10D2PE-001
SU10-D3	72NIR02SU10D3PE-001
SU10-D4	72NIR02SU10D4PE-001
SU10-E2	72NIR02SU10E2PE-001
SU10-E3	72NIR02SU10E3PE-001
SU10-E4	72NIR02SU10E4PE-001
SU10-F3	72NIR02SU10F3PE-001

TABLE 6-1

IR-02 AREA EXCAVATION SITES
SUMMARY OF WASTE MATERIALS

Material	Quantity[a]
Total Contaminated Soil and Debris	14,360 tons
LLRW – Soil	11,840 tons
LLRW – Debris	2,420 tons
LLRW – Wire Rope	100 tons
LLRW – Radiological Point Sources	2,033 devices 261 buttons 48 pieces debris 3 pieces of MPPEH debris
LLMW	2 drums
Over-pack Drums	48 drums
Wastewater/Decontamination Water	34,000 gallons
Compressed Gas Cylinders	30 cylinders
Non-LLRW – Wood and Tires	1,100 cy

Notes:

[a] Some of these items have not been disposed of at this time, and therefore the values are estimates only.

Abbreviations and Acronyms:

cy – cubic yard
IR – Installation Restoration
LLMW – low-level mixed waste
LLRW – low-level radiological waste
MPPEH – material potentially presenting an explosive hazard

TABLE 9-1

SUMMARY TABLE OF VALIDATION FINDINGS FOR SAMPLES ANALYZED FOR POLYCHLORINATED BIPHENYLS

Sample Number	Surrogate[a]
72-IR02-118	X
72-IR02-129	X
72-IR02-135	X
72-IR02-125	X
72-IR02-126	X
72-IR02-127	X

Notes:

[a] Surrogate %R was outside of QC limits for checked samples. Therefore, these samples were flagged "J".

Abbreviations and Acronyms:

%R – percent recovery
J – estimated value
QC – quality control

TABLE 9-2

SUMMARY TABLE OF VALIDATION FINDINGS FOR SAMPLES ANALYZED FOR PESTICIDES

Sample Number	Continuing Calibration[a]	Blanks[b]	Compound Quantitation[c]
72-IR02-097	X		X
72-IR02-098	X		X
72-IR02-099	X		X
72-IR02-108	X		X
72-IR02-109	X		X
72-IR02-110			X
72-IR02-111			X
72-IR02-112	X		X
72-IR02-113	X		X
72-IR02-114	X		X
72-IR02-115	X		X
72-IR02-116	X		X
72-IR02-117	X		X
72-IR02-118	X		X
72-IR02-119	X		
72-IR02-11A	X		
72-IR02-120	X		
72-IR02-121	X		X
72-IR02-122	X		X
72-IR02-123	X		X
72-IR02-124	X	X	X
72-IR02-125	X		X
72-IR02-126	X		X
72-IR02-127	X		X
72-IR02-128	X		X
72-IR02-129	X	X	
72-IR02-130	X		X
72-IR02-131	X	X	X
72-IR02-132	X		X
72-IR02-133	X		X
72-IR02-134	X	X	X
72-IR02-135	X		X

Notes:

[a] %D of continuing calibration did not meet the QC requirement for checked samples. Therefore, these samples were flagged "J/UJ".

[b] %R or RPDs outside of the QC limits for checked samples. Therefore, these samples were flagged "J/UJ".

[c] RPD outside of the QC limits for checked samples. Therefore, these detected samples were flagged "J".

Abbreviations and Acronyms:

%D – percent difference
%R – percent recovery
IR – Installation Restoration
J – estimated value
QC – quality control
RPD – relative percent difference
U – analyte not detected above project reporting limit

TABLE 9-3

SUMMARY TABLE OF VALIDATION FINDINGS FOR SAMPLES ANALYZED FOR METALS

Sample Number	Blanks[a]	ICP Serial Dilution[b]	MS/MSD[c]	Continuing Calibration[d]
72-IR02-098	X			
72-IR02-099	X			
72-IR02-108			X	
72-IR02-109			X	
72-IR02-110		X	X	
72-IR02-111		X	X	
72-IR02-112		X	X	
72-IR02-113		X	X	
72-IR02-114		X	X	
72-IR02-115		X	X	
72-IR02-116		X	X	
72-IR02-117		X	X	
72-IR02-118		X	X	
72-IR02-119		X	X	
72-IR02-120	X			
72-IR02-121		X	X	
72-IR02-122		X	X	
72-IR02-123			X	
72-IR02-124			X	
72-IR02-125			X	
72-IR02-126		X	X	
72-IR02-127		X	X	
72-IR02-128		X	X	
72-IR02-129				X
72-IR02-135	X			

Notes:

[a] Method blank contamination affected the checked samples. Sample concentrations which were either not detected

[b] ICP serial dilutions were outside of the QC limits for the checked samples. Therefore, these samples were flagged "J".

[c] %R or RPDs outside of the QC limits for checked samples. Therefore, these samples were flagged "J/UJ".

[d] %D of continuing calibration did not meet the QC requirement for checked samples. Therefore, these samples were flagged "J/UJ".

Abbreviations and Acronyms:

%D – percent difference
%R – percent recovery
ICP – inductively coupled plasma
IR – Installation Restoration
J – estimated value
MS – matrix spike
MSD – matrix spike duplicate
QC – quality control
RPD – relative percent difference
U – analyte not detected above project reporting limit

TABLE 9-4

SUMMARY TABLE OF VALIDATION FINDINGS FOR SAMPLES ANALYZED FOR SEMIVOLATILE ORGANIC COMPOUNDS

Sample Number	Blanks[a]	Internal Standards[b]	Continuing Calibration[c]
72-IR02-108			X
72-IR02-109			X
72-IR02-110			X
72-IR02-111			X
72-IR02-112			X
72-IR02-113			X
72-IR02-114			X
72-IR02-115			X
72-IR02-116			X
72-IR02-117			X
72-IR02-118			X
72-IR02-119			X
72-IR02-120	X		X
72-IR02-121			X
72-IR02-122			X
72-IR02-123			X
72-IR02-124			X
72-IR02-125			X
72-IR02-126		X	X
72-IR02-127			X
72-IR02-128			X
72-IR02-129			X
72-IR02-130			X
72-IR02-131			X
72-IR02-132			X
72-IR02-133			X
72-IR02-134			X
72-IR02-135			X

Notes:

[a] Method blank contamination affected the checked samples. Sample concentrations either not detected or less than 5 times blank contaminant concentrations were flagged "U".

[b] %R outside of the QC limits for checked samples. Therefore, these samples were flagged "J/UJ".

[c] %D of continuing calibration did not meet the QC requirement for checked samples. Therefore, these samples were flagged "J/UJ".

Abbreviations and Acronyms:

%D – percent difference
%R – percent recovery
IR – Installation Restoration
J – estimated value
QC – quality control
U – analyte not detected above project reporting limit

TABLE 9-5

SUMMARY TABLE OF VALIDATION FINDINGS FOR SAMPLES ANALYZED FOR TOTAL PETROLEUM HYDROCARBONS

Sample Number	Blanks[a]
72-IR02-120	X

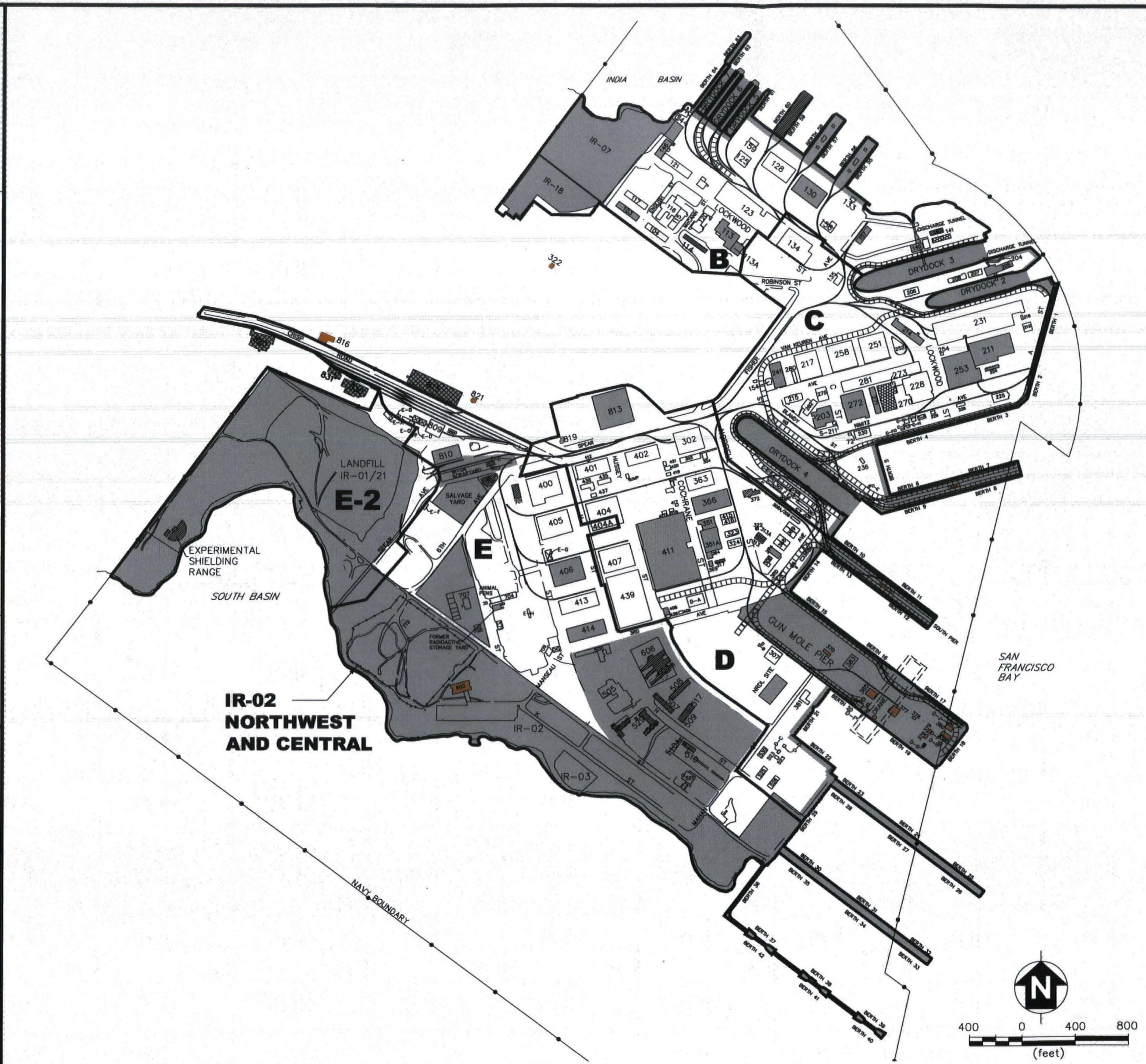
Notes:

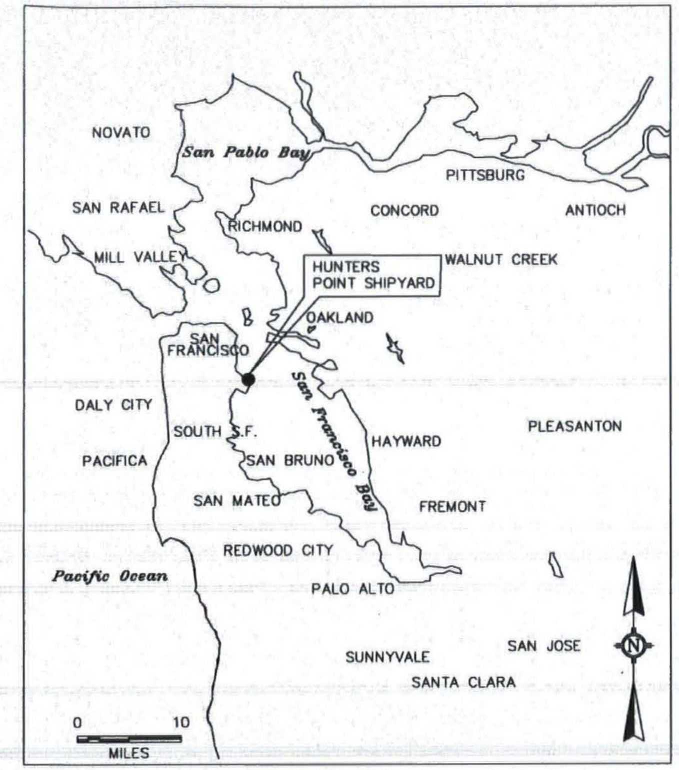
[a] Method blank contamination affected the checked samples.
Sample concentrations were either not detected or less than 5 times blank contaminant concentrations were flagged "U".

Abbreviations and Acronyms:

IR – Installation Restoration

FIGURES





KEY MAP

LEGEND

- NAVY PROPERTY BOUNDARY (OFFSHORE)
- 6-FOOT TEMPORARY FENCE
- TOP OF EXCAVATION SLOPE
- PARCEL BOUNDARIES
- IMPACTED BUILDINGS OR SITES
- DEMOLISHED IMPACTED BUILDINGS/STRUCTURES
- DEMOLISHED BUILDINGS/STRUCTURES
- IMPACTED SITES THAT HAVE OBTAINED REGULATORY RELEASE
- IMPACTED FUDS SITES
- NON-IMPACTED BUILDINGS WITHIN AN IMPACTED SITE, RADIOLOGICAL PRECAUTIONS MAY BE REQUIRED

NOTE

IMPACTED SITES ARE SITES THAT HAVE KNOWN RADIOLOGICAL CONTAMINATION OR WHERE SITE HISTORY INDICATES THAT RADIOLOGICAL CONTAMINATION MAY BE PRESENT.

DATUM

HORIZONTAL DATUM: NAD 27
VERTICAL DATUM: NGVD 29

ABBREVIATIONS AND ACRONYMS

IR	INSTALLATION RESTORATION SITE
FUDS	FORMERLY USED DEFENSE SITES

FIGURE 1-1
HUNTERS POINT SHIPYARD AND IR-02 LOCATION MAP

HUNTERS POINT SHIPYARD-SAN FRANCISCO, CALIFORNIA

TETRA TECH EC, INC.

DRAWN BY: KLD | CHECKED BY: BKM | APPROVED BY: RA | DCN: ECSD-5713-0072-0005 | DRAWING NO: 0072000511.DWG
DATE: 12/12/07 | CTO: 0072

I:\1990-RAC\CTO-0072\DWG\00720005\0072000511.DWG
PLOT/UPDATE: MAY 26 2005 08:09:41

DRAWING NO: 0072000121.DWG
DCN: ECSD-5713-0072-0005
CTO: 0072
APPROVED BY: RA
CHECKED BY: BKM
DRAWN BY: KLD
DATE: 12/12/07

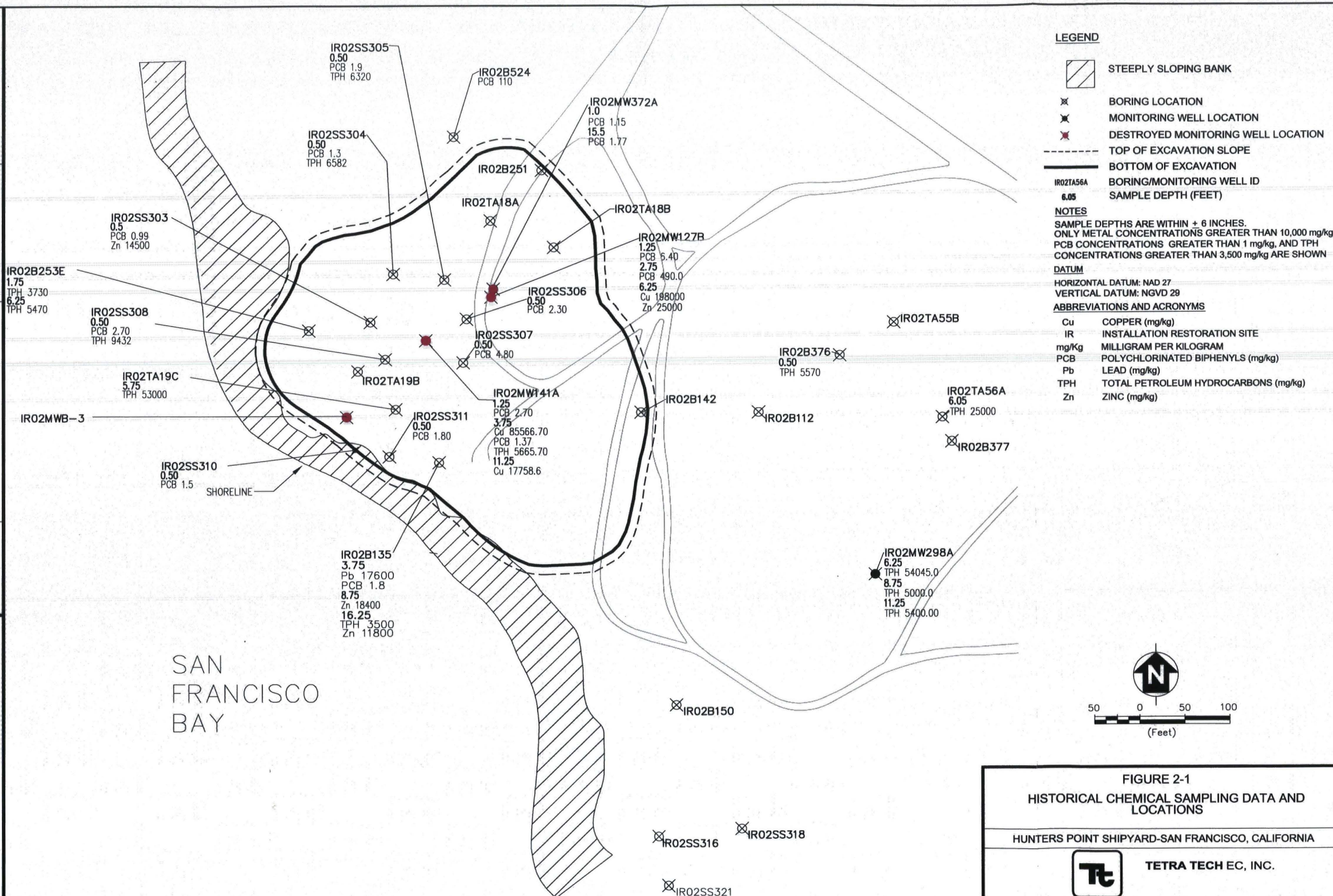


FIGURE 2-1
HISTORICAL CHEMICAL SAMPLING DATA AND LOCATIONS

HUNTERS POINT SHIPYARD-SAN FRANCISCO, CALIFORNIA

TETRA TECH EC, INC.

:\1990-RAC\CTO-0072\DWG\0072-0005\0072000521.DWG
PLOT/UPDATE: MAY 26 2005 09:44:47

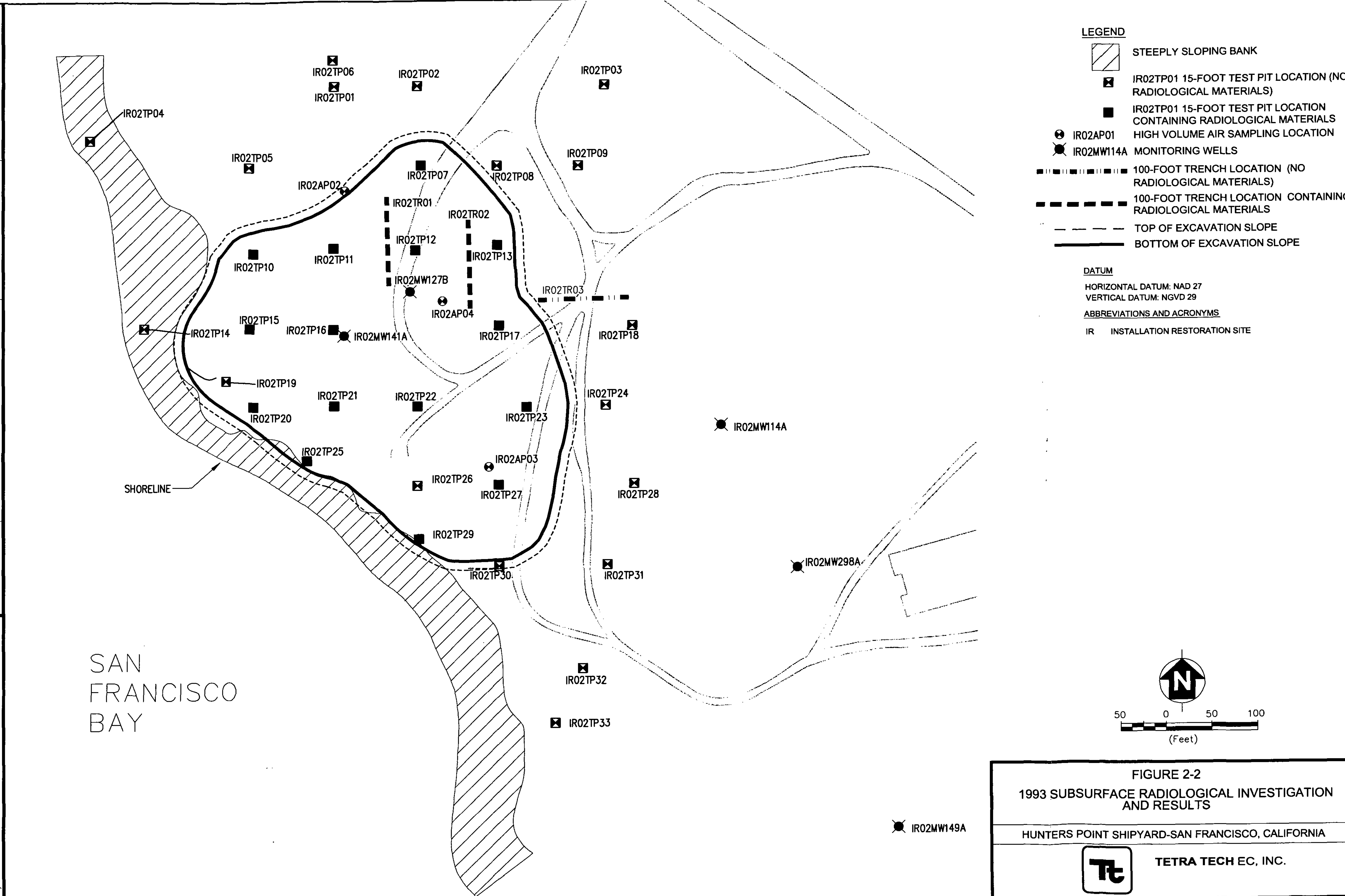


FIGURE 2-2

1993 SUBSURFACE RADIOLOGICAL INVESTIGATION AND RESULTS

HUNTERS POINT SHIPYARD-SAN FRANCISCO, CALIFORNIA

TETRA TECH EC, INC.

DRAWN BY: KLD
DATE: 12/12/07
CHECKED BY: BKM
APPROVED BY: RA
DCN: ECSD-5713-0072-0005
CTO: 0072
DRAWING NO: 0072000522.DWG

I:\1990-RAC\CTO-0072\DWG\0072-0005\0072000522.DWG
PLOT/UPDATE: MAY 26 2005 09:44:47

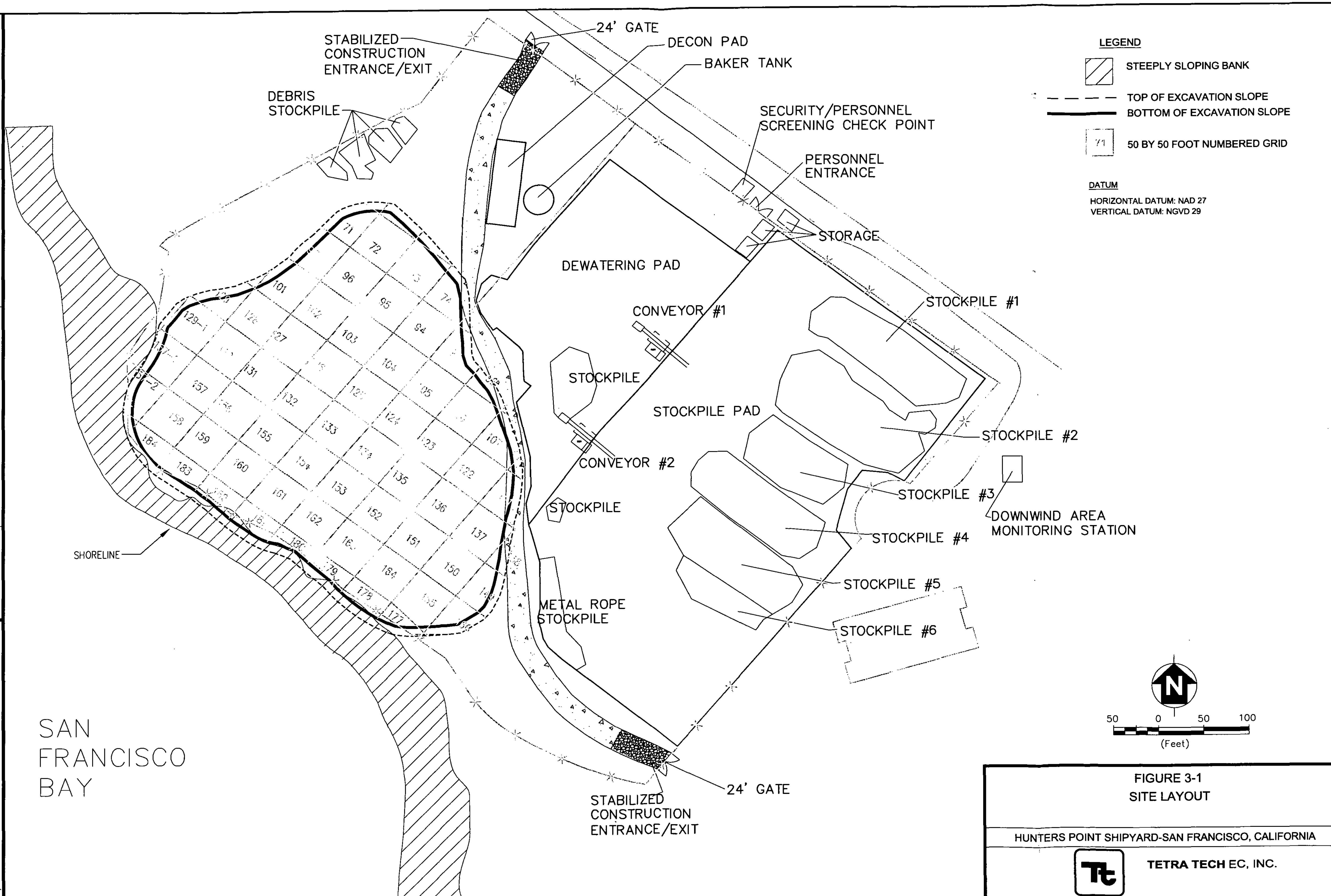


FIGURE 3-1
SITE LAYOUT

HUNTERS POINT SHIPYARD-SAN FRANCISCO, CALIFORNIA

TETRA TECH EC, INC.

DRAWN BY: KLD | DATE: 12/12/07 | CHECKED BY: BM | APPROVED BY: GS | DCN: ECSD-5713-0072-0005 | CTO: 0072 | DRAWING NO: 0072000531.DWG

I:\1990-RAC\CTO-0072\DWG\0072-0005\0072000531.DWG
PLOT/UPDATE: MAY 26 2005 09:44:47

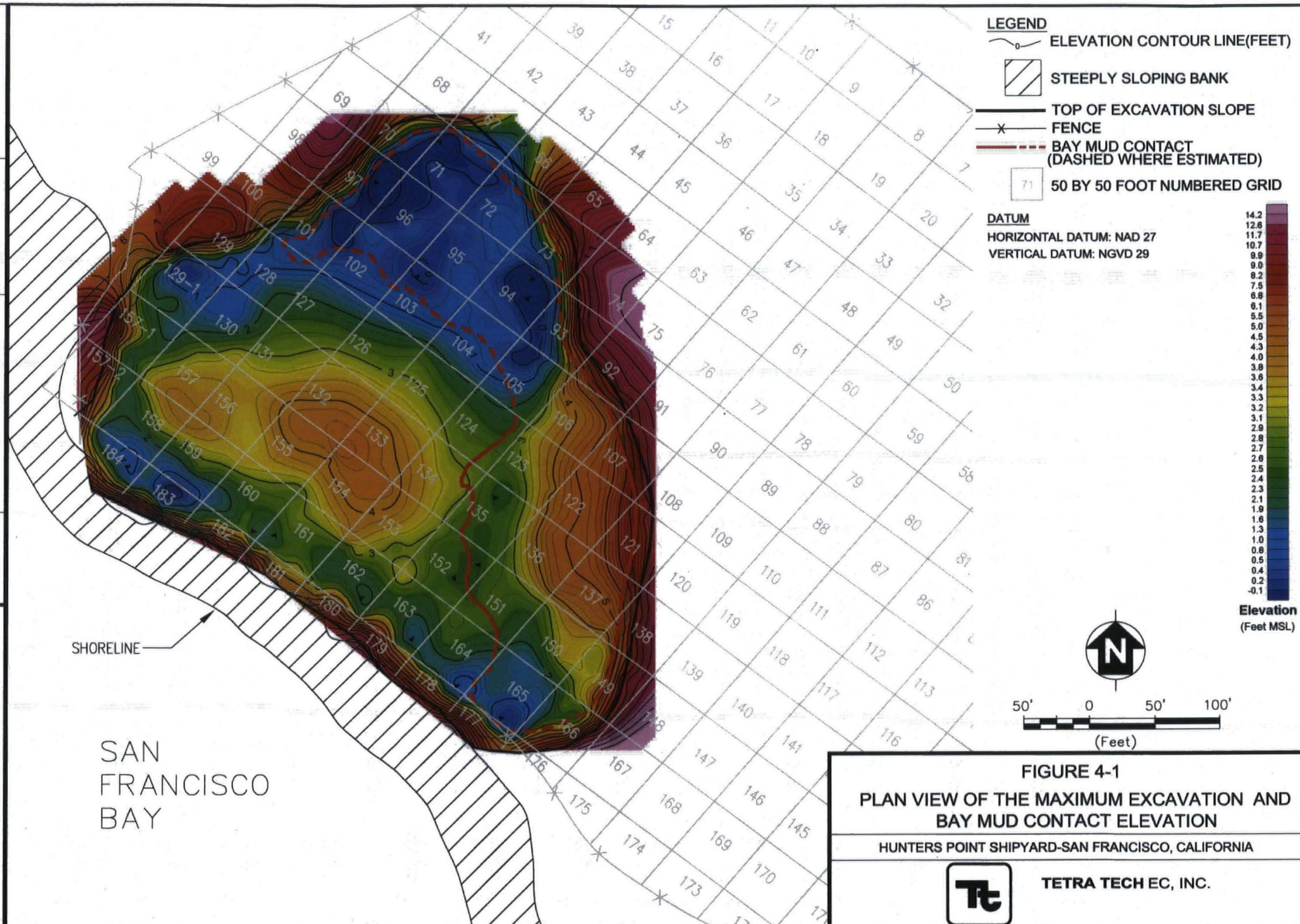


FIGURE 4-1

PLAN VIEW OF THE MAXIMUM EXCAVATION AND BAY MUD CONTACT ELEVATION

HUNTERS POINT SHIPYARD-SAN FRANCISCO, CALIFORNIA

TETRA TECH EC, INC.

DRAWN BY: KLD | DATE: 12/12/07 | CHECKED BY: BKM | APPROVED BY: RA | DCN: ECSD-5713-0072-0005 | CTO: 0072 | DRAWING NO: 0072000541.DWG

I:\1990-RAC\CTO-0072\DWG\0072-0005\0072000541.DWG
PLOT/UPDATE: MAY 26 2005 09:44:47

DRAWN BY: KLD | DATE: 12/12/07 | CHECKED BY: BKM | APPROVED BY: RA | DCN: ECSD-5713-0072-0005 | CTO: 0072 | DRAWING NO: 0072000542.DWG

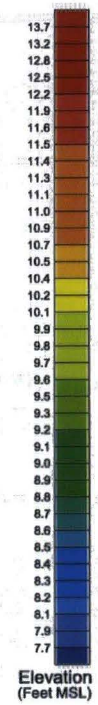
I:\1990-RAC\CTO-0072\DWG\0072-0005\0072000542.DWG
PLOT/UPDATE: MAY 26 2005 09:44:47

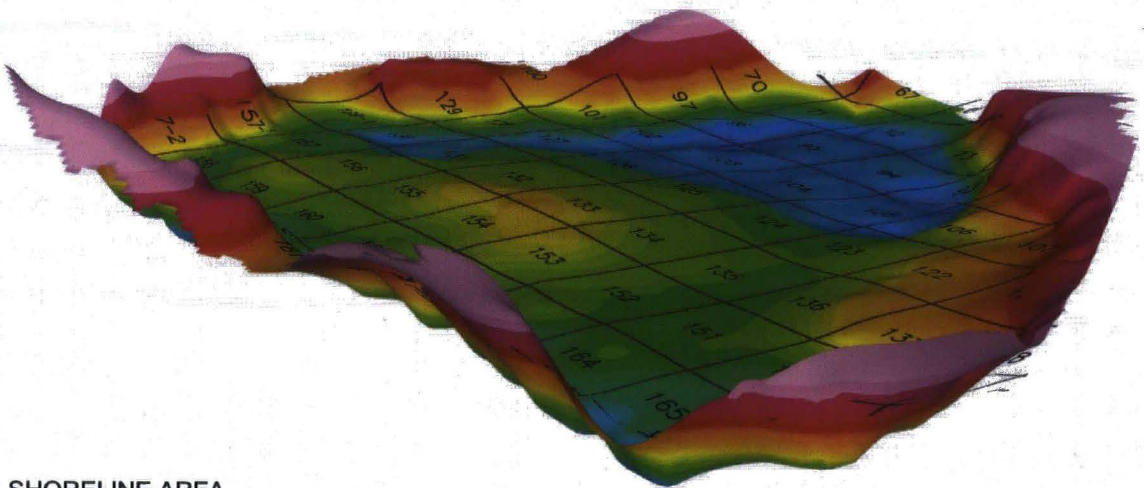
LEGEND

71 — 50 BY 50 FOOT NUMBERED GRID

DATUM

HORIZONTAL DATUM: NAD 27
VERTICAL DATUM: NGVD 29





SHORELINE AREA

FIGURE 4-2

THREE- DIMENSIONAL VIEW OF THE
POST- EXCAVATION BOTTOM AND SIDEWALL

HUNTERS POINT SHIPYARD-SAN FRANCISCO, CALIFORNIA

TETRA TECH EC, INC.

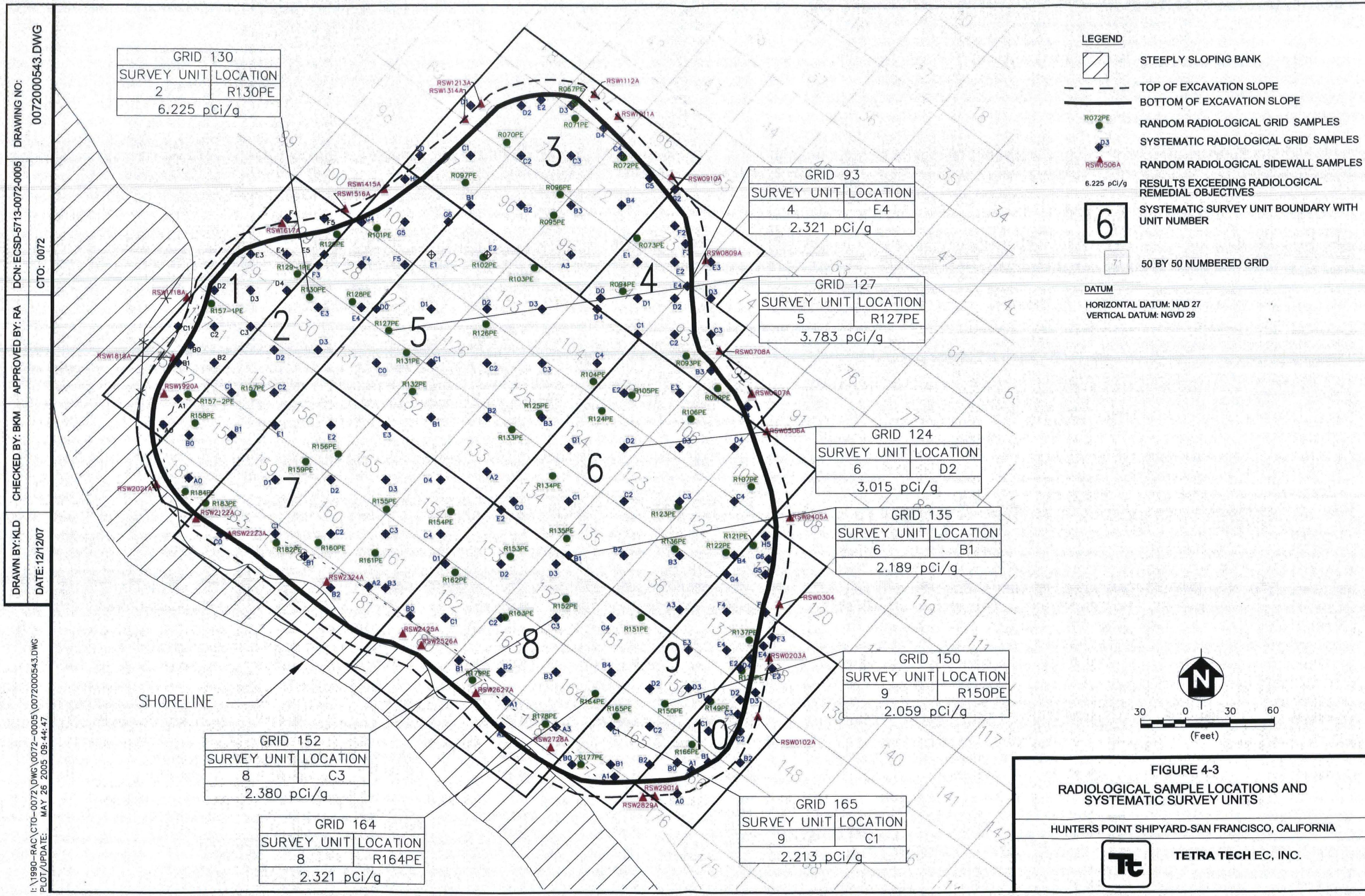


FIGURE 4-3
RADIOLOGICAL SAMPLE LOCATIONS AND SYSTEMATIC SURVEY UNITS

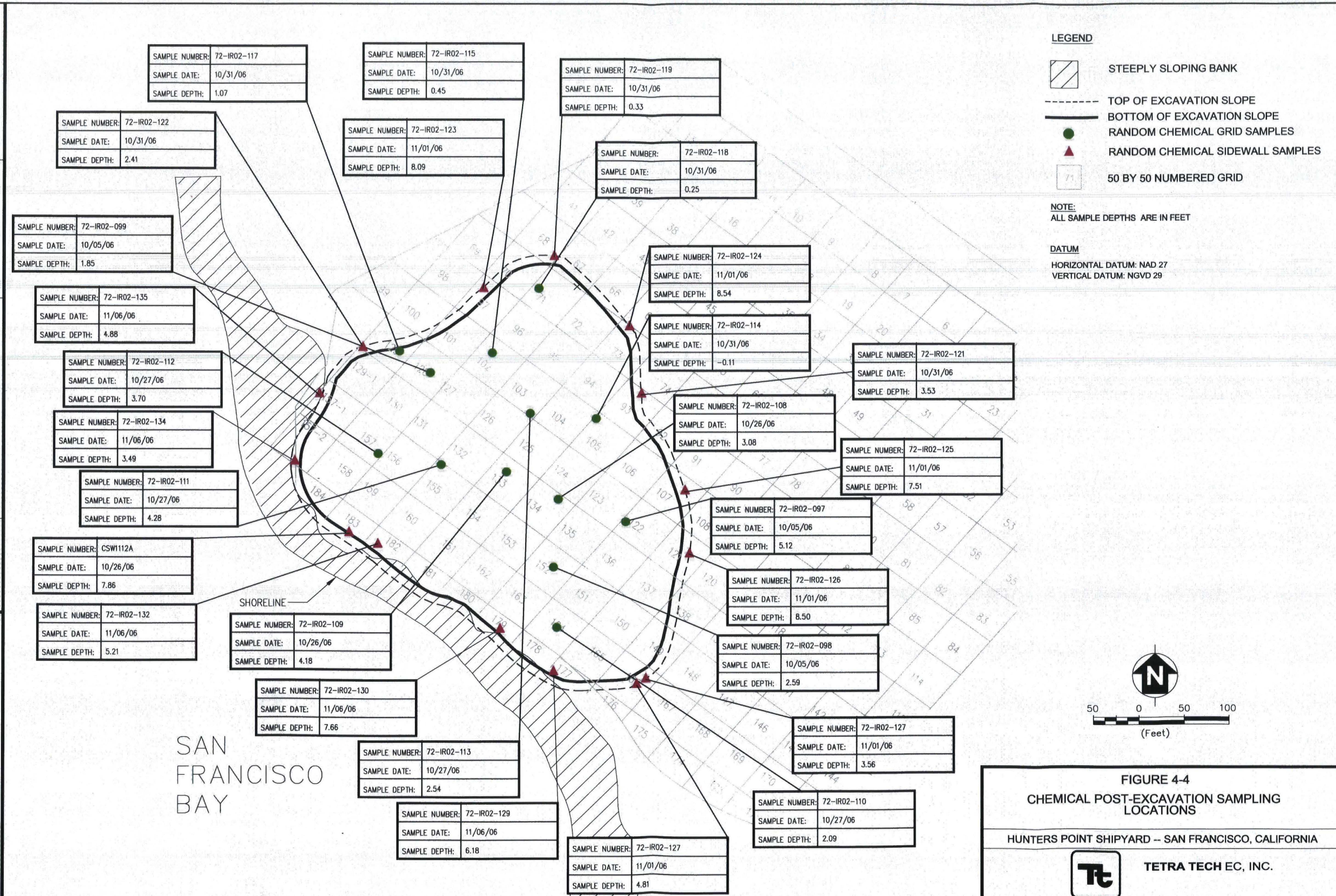


FIGURE 4-4
CHEMICAL POST-EXCAVATION SAMPLING LOCATIONS

HUNTERS POINT SHIPYARD -- SAN FRANCISCO, CALIFORNIA

TETRA TECH EC, INC.

DRAWING NO: 072000144.DWG
DCN: ECSD-5713-0072-0001
CTO: 0072
APPROVED BY: RA
CHECKED BY: BKM
DRAWN BY: KLD
DATE: 07/09/07

:\1990-RAC\CTO-0072\DWG\0072-0001\072000143.DWG
PLOT/UPDATE: MAY 26 2005 09:44:47

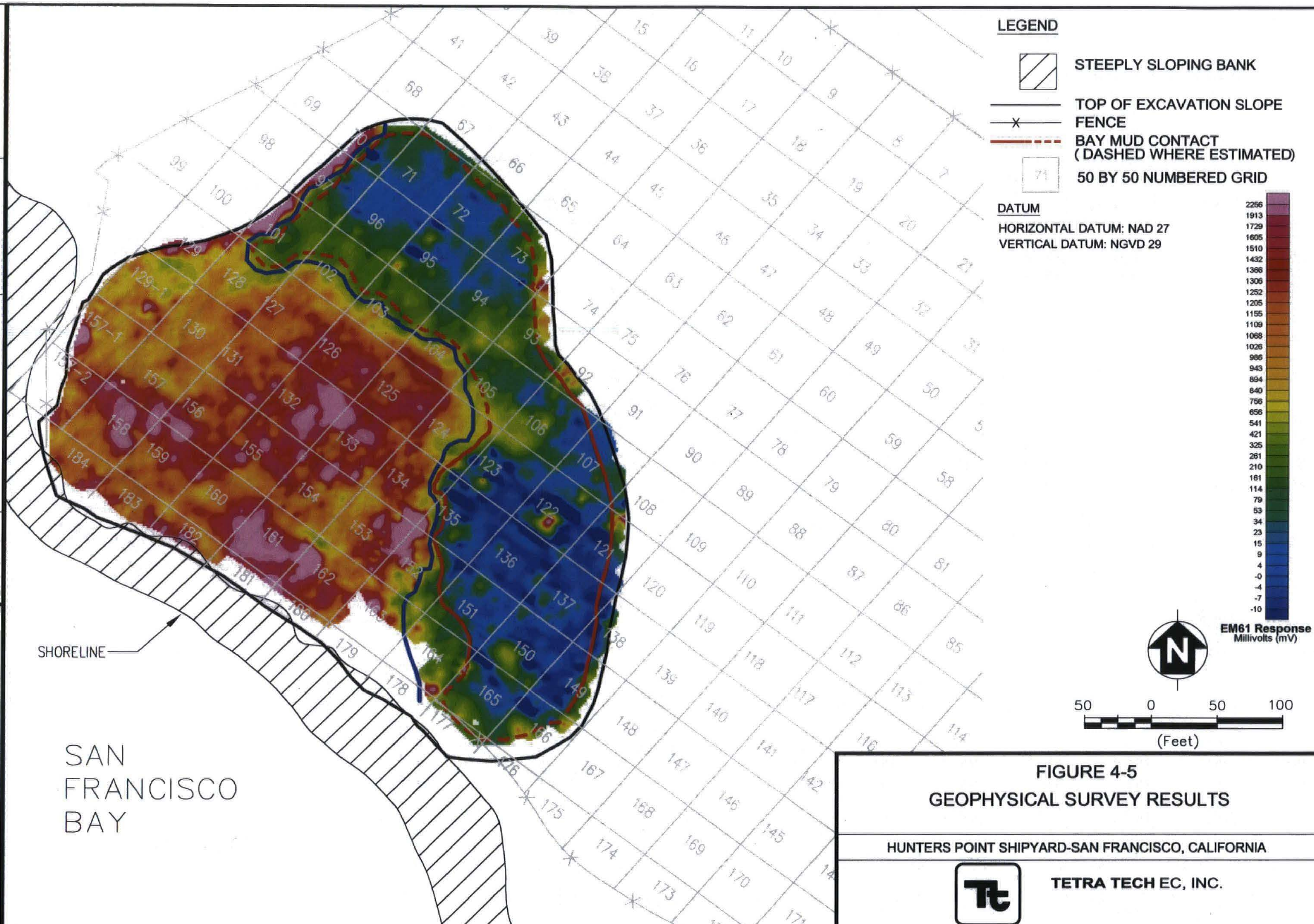


FIGURE 4-5
GEOPHYSICAL SURVEY RESULTS

HUNTERS POINT SHIPYARD-SAN FRANCISCO, CALIFORNIA

TETRA TECH EC, INC.

DRAWN BY: KLD | DATE: 12/12/07 | CHECKED BY: BKM | APPROVED BY: RA | DCN: ECSD-5713-0072-0005 | CTO: 0072 | DRAWING NO: 0072000544.DWG

I:\1990-RAC\CTO-0072\DWG\0072-0005\0072000549.DWG
PLOT/UPDATE: MAY 26 2005 09:44:47

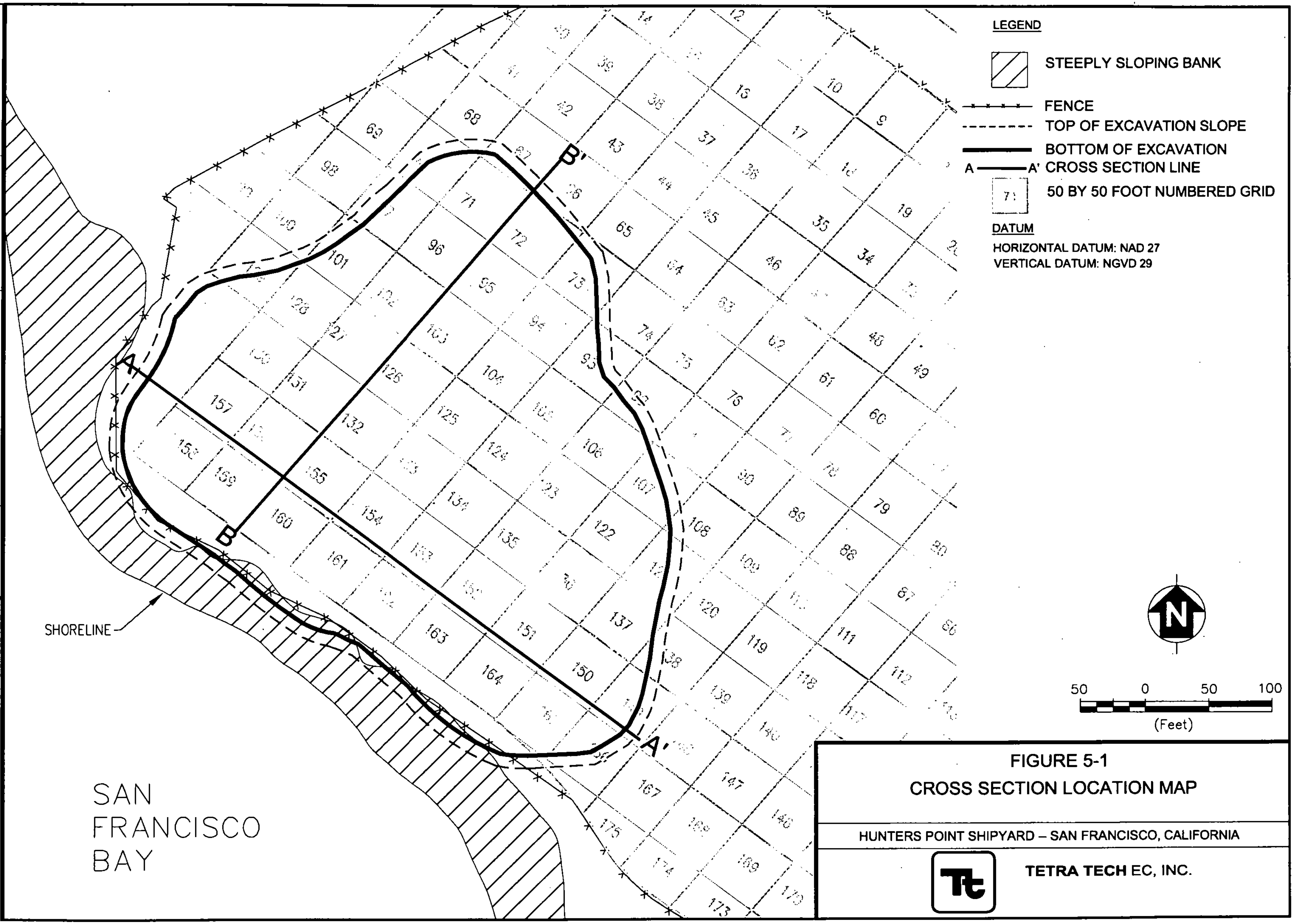


FIGURE 5-1
CROSS SECTION LOCATION MAP

HUNTERS POINT SHIPYARD – SAN FRANCISCO, CALIFORNIA

TETRA TECH EC, INC.

DRAWN BY: KLD | CHECKED BY: BKM | APPROVED BY: RA | DCN: ECSD-5713-0072-0005 | DRAWING NO: 0072000551.DWG

DATE: 12/12/07 | CTO: 0072

:\1990-RAC\CTO-0072\DWG\0072-0005\0072000551.DWG
PLOT/UPDATE: MAY 26 2005 09:44:47

LEGEND

▼ GROUNDWATER LEVEL

NOTE:
LAYERS 1 THROUGH 10 ARE EXCAVATED MATERIAL USED AS BACKFILL

DATUM
HORIZONTAL DATUM: NAD 27
VERTICAL DATUM: NGVD 29

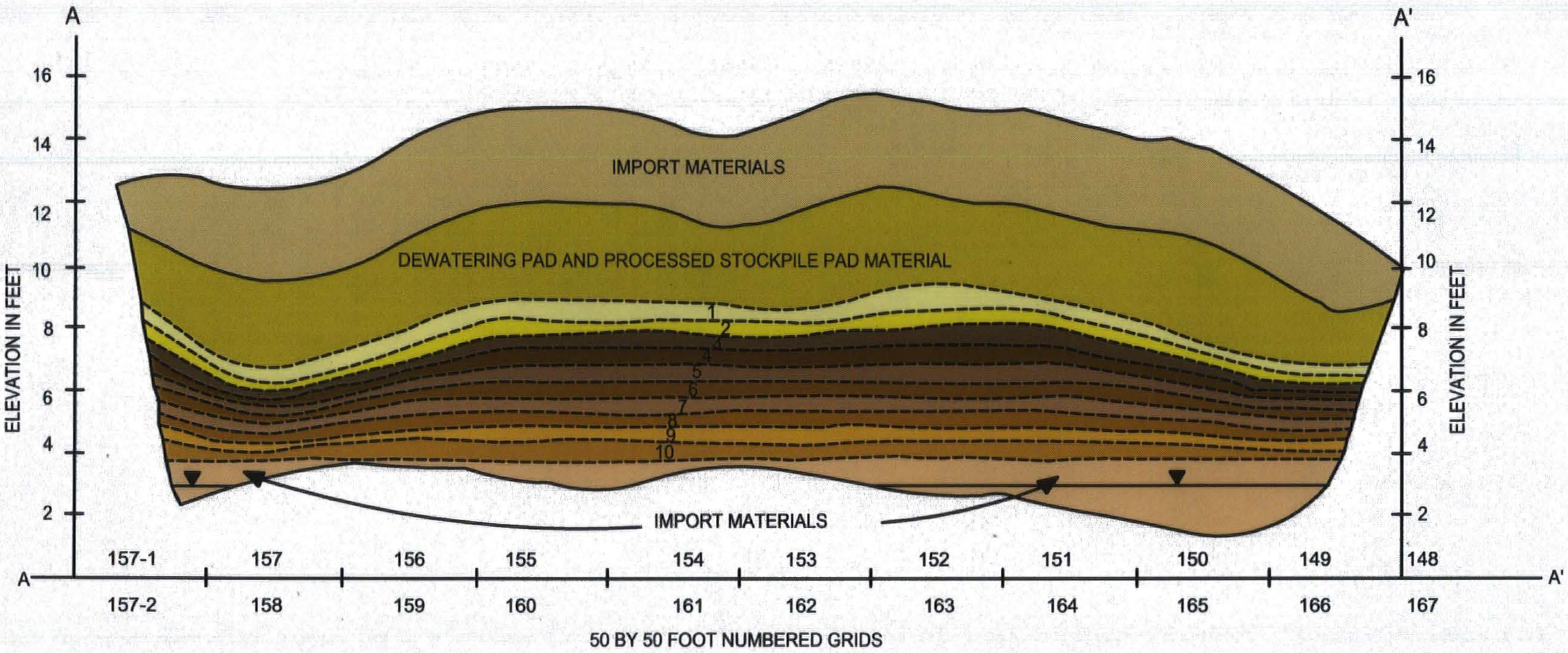


FIGURE 5-2
CROSS SECTION A-A'

HUNTERS POINT SHIPYARD -- SAN FRANCISCO, CALIFORNIA

TETRA TECH EC, INC.

DRAWING NO: 0072000552.DWG
DCN: ECSD-5713-0072-0001
CTO: 0072
APPROVED BY: RA
CHECKED BY: BKM
DRAWN BY: KLD
DATE: 12/12/07

I:\1990-RAC\CTO-0072\DWG\0072-0005\0072000552.DWG
PLOT/UPDATE: MAY 26 2005 09:44:47

LEGEND

▼ GROUNDWATER LEVEL

NOTE:

LAYERS 1 THROUGH 10 ARE EXCAVATED MATERIAL USED AS BACKFILL

DATUM

HORIZONTAL DATUM: NAD 27
VERTICAL DATUM: NGVD 29

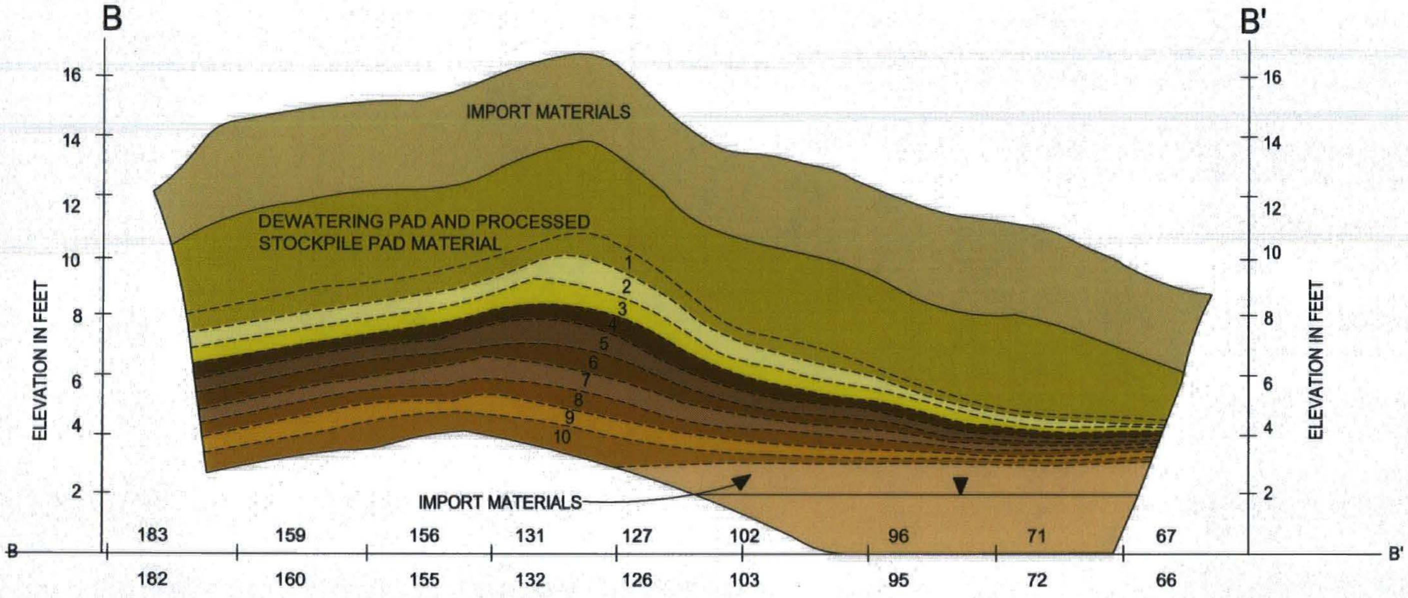


FIGURE 5-3

CROSS SECTION B-B'

HUNTERS POINT SHIPYARD – SAN FRANCISCO, CALIFORNIA

TETRA TECH EC, INC.

DRAWN BY: KLD | CHECKED BY: BKM | APPROVED BY: RA | DCN: ECSD-5713-0072-0005 | DRAWING NO: 00720005453.DWG

DATE: 12/12/07 | CTO: 0072

I:\1990-RAC\CTO-0072\DWG\0072-0005\0072000553.DWG
PLOT/UPDATE: MAY 26 2005 09:44:47

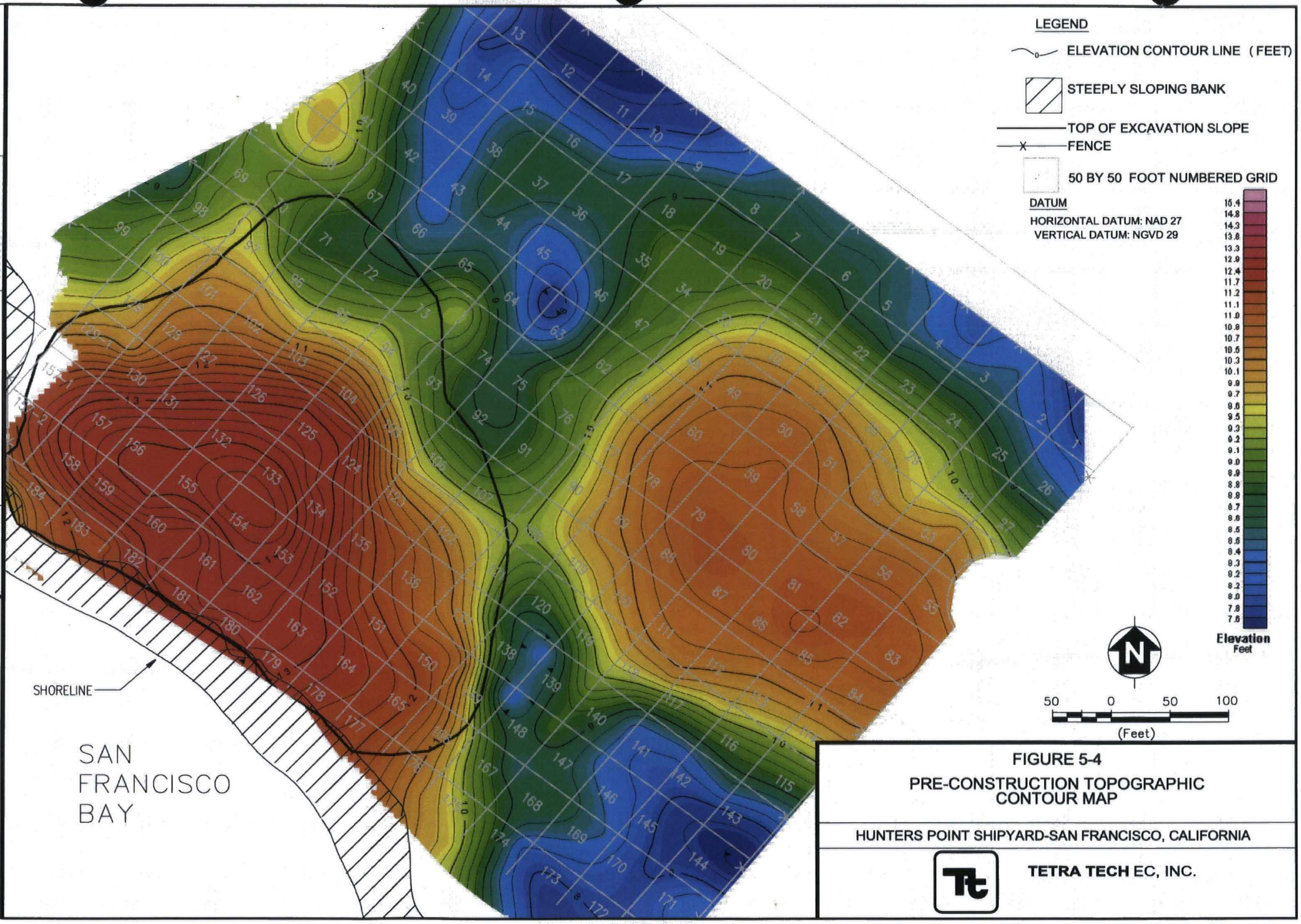


FIGURE 5-4
PRE-CONSTRUCTION TOPOGRAPHIC CONTOUR MAP

HUNTERS POINT SHIPYARD-SAN FRANCISCO, CALIFORNIA

TETRA TECH EC, INC.

DRAWING NO: 0072000554.DWG

DCN: ECSD-5713-0072-0005

CTO: 0072

APPROVED BY: RA

CHECKED BY: BKM

DRAWN BY: KLD

DATE: 12/12/07

I:\1990-RAC\CTO-0072\DWG\0072-0005\0072000551.DWG
PLOT/UPDATE: MAY 26 2005 09:44:47

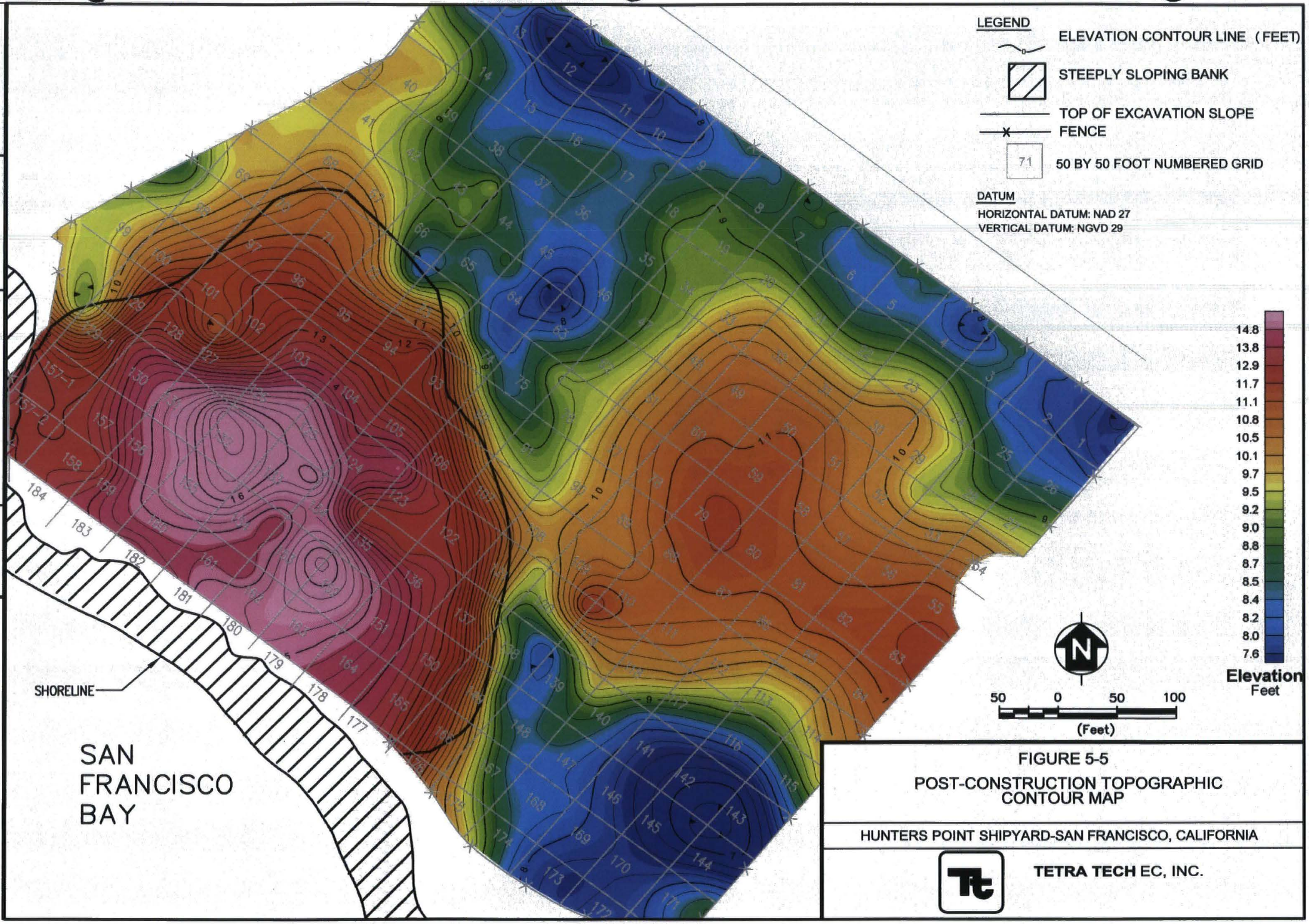


FIGURE 5-5

POST-CONSTRUCTION TOPOGRAPHIC CONTOUR MAP

HUNTERS POINT SHIPYARD-SAN FRANCISCO, CALIFORNIA

TETRA TECH EC, INC.

DRAWING NO: 00720005455.DWG

DCN: ECSD-5713-0072-0005

CTO: 0072

APPROVED BY: RA

CHECKED BY: BKM

DRAWN BY: KLD

DATE: 12/12/07

I:\1990-RAC\CTO-0072\DWG\0072-0005\00720000555.DWG
PLOT/UPDATE: MAY 26 2005 09:44:47

APPENDIX A

WEATHER DATA AND AIR MONITORING REPORT

(AVAILABLE ON CD ONLY)

APPENDIX B

KICK-OFF MEETING AGENDA

(AVAILABLE ON CD ONLY)

APPENDIX C

WELL DESTRUCTION FORMS

(AVAILABLE ON CD ONLY)

APPENDIX D

POST-EXCAVATION CHEMICAL SAMPLING RESULTS IR-02 AREA

(AVAILABLE ON CD ONLY)

APPENDIX E

BACKFILL MATERIAL REVIEW AND ACCEPTANCE DOCUMENTATION

(AVAILABLE ON CD ONLY)

APPENDIX F

WASTE DATA AND WASTE MANIFESTS

(Container Inventory and Drum Log Included)

(AVAILABLE ON CD ONLY)

APPENDIX G

RADIOLOGICAL POST-EXCAVATION SAMPLING RESULTS AND SCAN DATA

(AVAILABLE ON CD ONLY)

APPENDIX H

SURVEY REPORTS

(AVAILABLE ON CD ONLY)

APPENDIX I

PROJECT PHOTOGRAPHS

(AVAILABLE ON CD ONLY)

APPENDIX J

FIELD CHANGE REQUEST (FCR) LOG AND FCRs

(AVAILABLE ON CD ONLY)

APPENDIX K

COMMUNITY RELATIONS DOCUMENTS

(AVAILABLE ON CD ONLY)

APPENDIX L

VALIDATED ANALYTICAL DATA PACKAGES

(AVAILABLE ON CD ONLY)

APPENDIX M

RADIOLOGICAL OFF-SITE SAMPLE ANALYSIS RESULTS

(AVAILABLE ON CD ONLY)

APPENDIX N

RESPONSE TO COMMENTS

(AVAILABLE ON CD ONLY)